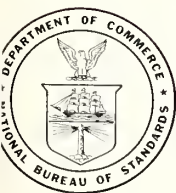


Central Radio Propagation Laboratory

IONOSPHERIC PREDICTIONS

*for
November
1963*

TB 11-499-8/TO 31-3-28



U.S. DEPARTMENT of COMMERCE
National Bureau of Standards
Number 8/Issued August 1963

U.S. DEPARTMENT OF COMMERCE

Luther H. Hodges, Secretary



NATIONAL BUREAU OF STANDARDS

A. V. Astin, Director

Central Radio Propagation Laboratory

Ionospheric Predictions

for November 1963

[Formerly "Basic Radio Propagation Predictions," CRPL Series D.]

Number 8

Issued

August 1963

The CRPL Ionospheric Predictions are issued monthly as an aid in determining the best sky-wave frequencies over any transmission path, at any time of day, for average conditions for the month. Issued three months in advance, each issue provides tables

of numerical coefficients that define the functions describing the predicted worldwide distribution of f_oF_2 and $M(3000)F_2$ and maps for each even hour of universal time of $MUF(Zero)F_2$ and $MUF(4000)F_2$.

NOTE: Department of Defense personnel see back cover.

Use of funds for printing this publication approved by the Director of the Bureau of the Budget (June 19, 1961).

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 15 cents

Annual subscription (12 issues) \$1.50 (50 cents additional for foreign mailing).

National Bureau of Standards

The functions of the National Bureau of Standards are set forth in an Act of Congress, March 3, 1901, as amended. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to government agencies on scientific and tech-

nical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. The Bureau also serves as the Federal technical research center in a number of specialized fields.

Central Radio Propagation Laboratory

The Central Radio Propagation Laboratory at Boulder, Colorado, is the central agency of the Federal Government for the collection, analysis, and dissemination of information on propagation of radio waves at all frequencies along the surface of the earth, in the atmosphere, and in space, and performs scientific studies looking toward new techniques for the efficient use and conservation of the radio spectrum. To carry out this responsibility, the CRPL—

1. Acts as the central agency for the conduct of basic research on the nature of radio waves, the pertinent properties of the media through which radio waves are transmitted, the interaction of radio waves with those media, and on the nature of radio noise and interference effects. This includes compilation of reports by other foreign and domestic agencies conducting research in this field and furnishing advice to government and nongovernment groups conducting propagation research.

2. Performs studies of specific radio propagation mechanisms and performs scientific studies looking

toward the development of techniques for efficient use and conservation of the radiofrequency spectrum as part of its regular program or as requested by other government agencies. In an advisory capacity, coordinates studies in this area undertaken by other government agencies.

3. Furnishes advisory and consultative service on radio wave propagation, on radiofrequency utilization, and on radio systems problems to other organizations within the United States, public and private.

4. Prepares and issues predictions of radio wave propagation and noise conditions and warnings of disturbances in these conditions.

5. Acts as a central repository for data, reports, and information in the field of radio wave propagation.

6. Performs scientific liaison and exchanges data and information with other countries to advance knowledge of radio wave propagation and interference phenomena and spectrum conservation techniques, including that liaison required by international responsibilities and agreements.

Introduction

The "Central Radio Propagation Laboratory Ionospheric Predictions" is the successor to the former "Basic Radio Propagation Predictions," CRPL Series D. To make effective use of these predictions, National Bureau of Standards Handbook 90, "Handbook for CRPL Ionospheric Predictions Based on Numerical Methods of Mapping," should be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402, price 40 cents. This Handbook includes required additional data, nomographs and graphical aids, as well as methods for the use of the predictions. The Handbook supersedes the obsolete NBS Circular 465.

The basic prediction appears in tables 1 and 2, presenting predicted coefficients for foF2 and M(3000)F2 defining the numerical map functions describing the predicted worldwide variation of these characteristics. With additional auxiliary information, these coefficients may be used as input data for electronic computer programs solving specific high frequency propagation problems. The basic equations, their interpretation, and methods of using the numerical maps are described in two papers by W. B. Jones and R. M. Gallet, "The Representation of Diurnal and Geographic Variations of Ionospheric Data by Numerical Methods," Volume 66D, Number 4, July-August 1962, pages 419-438, and "Methods for Applying Numerical Maps of Ionospheric Characteristics," Volume 66D, Number 6, November-December 1962, pages 649-662, both in the Journal of Research of the National Bureau of Standards, Section D. Radio Propagation. The predicted numerical map coefficients of tables 1 and 2 may be purchased in the form of a tested set of punched cards. Write to the Prediction Services Section, Central Radio Propagation Laboratory, National Bureau of Standards, Boulder, Colorado, to arrange for the purchase of the set of punched cards and for further information and assistance in the application of computer methods and numerical prediction maps to specific propagation problems.

The graphical prediction maps, derived from the basic prediction, are provided for those unable to make use of an electronic computer. Figures 1 to 12 present world maps of MUF (Zero) F2 and MUF(4000)F2 for each even hour of universal time. Figures 13 to 16 present the same predictions for hours 00 and 12 universal time for the North and South Polar areas. Predicted polar maps for each even hour of universal time may be obtained by special arrangements with the Central Radio Propagation Laboratory. Handbook 90 describes methods for including regular E-F1 propagation. Figure A is a graph of predicted and observed Zürich sunspot numbers which shows the recent trend of solar activity. Table A lists observed and predicted Zürich smoothed relative sunspot numbers and includes the sunspot number used for the current prediction.

Members of the U.S. Army, Navy, or Air Force desiring the Handbook and the Ionospheric Predictions should send requests to the proper service address; for the Navy: The Director, Naval Communications, Department of the Navy, Washington, D.C. 20350; for the Air Force: Directorate of Command Control and Communications, Headquarters, United States Air Force, Washington, D.C. 20330, Attention: AFOSCAA. Army personnel should refer to the Handbook as TM 11-499 and to the monthly predictions as TB 11-499-(), predictions for the month of November 1963 being distributed in August 1963 and designated TB 11-499-(8), and should requisition these through normal publication channels.

Information concerning the theory of radio wave propagation and such important problems as absorption, field intensity, lowest useful high frequencies, etc., is given in National Bureau of Standards Circular 462, "Ionospheric Radio Propagation." A revised work is in preparation which will be announced in the Ionospheric Prediction series when available. Additional information about radio noise may be found in C.C.I.R. Report Number 65, "Revision of Atmospheric Noise Data," International Telecommunication Union, Geneva, 1957.

Reports to this Laboratory of experience with these predictions would be appreciated. Correspondence should be addressed to the Prediction Services Section, Central Radio Propagation Laboratory, National Bureau of Standards, Boulder, Colorado.

Table A

Observed and Predicted Zurich Smoothed Relative
Sunspot Numbers

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1952	43 (53)	42 (51)	39 (52)	36 (52)	34 (52)	32 (52)	31 (51)	29 (49)	28 (46)	28 (43)	27 (38)	26 (33)
1953	24 (30)	22 (29)	20 (27)	19 (24)	17 (22)	15 (21)	13 (20)	12 (18)	11 (18)	10 (17)	9 (16)	7 (15)
1954	6 (14)	6 (12)	4 (11)	3 (10)	4 (10)	4 (9)	5 (8)	7 (8)	8 (8)	8 (10)	10 (10)	12 (11)
1955	14 (12)	16 (14)	20 (14)	23 (13)	29 (16)	35 (18)	40 (22)	46 (27)	55 (30)	64 (31)	73 (35)	81 (42)
1956	89 (48)	98 (53)	109 (60)	119 (68)	127 (77)	137 (89)	146 (95)	150 (105)	151 (119)	156 (135)	160 (147)	164 (150)
1957	170 (150)	172 (150)	174 (150)	181 (150)	186 (150)	188 (150)	191 (150)	194 (150)	197 (150)	200 (150)	201 (150)	200 (150)
1958	199 (150)	201 (150)	201 (150)	197 (150)	191 (150)	187 (150)	185 (150)	185 (150)	184 (150)	182 (150)	181 (150)	180 (150)
1959	179 (150)	177 (150)	174 (150)	169 (150)	165 (146)	161 (143)	156 (141)	151 (142)	146 (141)	141 (139)	137 (137)	132 (137)
1960	129 (136)	125 (135)	122 (133)	120 (130)	117 (125)	114 (120)	109 (118)	102 (115)	98 (110)	93 (108)	88 (105)	84 (100)
1961	80 (100)	75 (90)	69 (90)	64 (90)	60 (85)	56 (85)	53 (80)	52 (75)	52 (70)	51 (70)	50 (65)	49 (60)
1962	45 (60)	42 (50)	40 (48)	39 (45)	39 (42)	38 (37)	36 (34)	34 (31)	32 (29)	31 (28)	30 (27)	34 (34)
1963	(31)	(28)	(26)	(25)	(25)	(25)	(23)	(21)	(20)	(18)	(18)*	
1964												

Note: Final numbers are listed through June 1962, the succeeding values being based on provisional data. The predicted numbers are in parentheses.

* Number used for predictions in this issue.

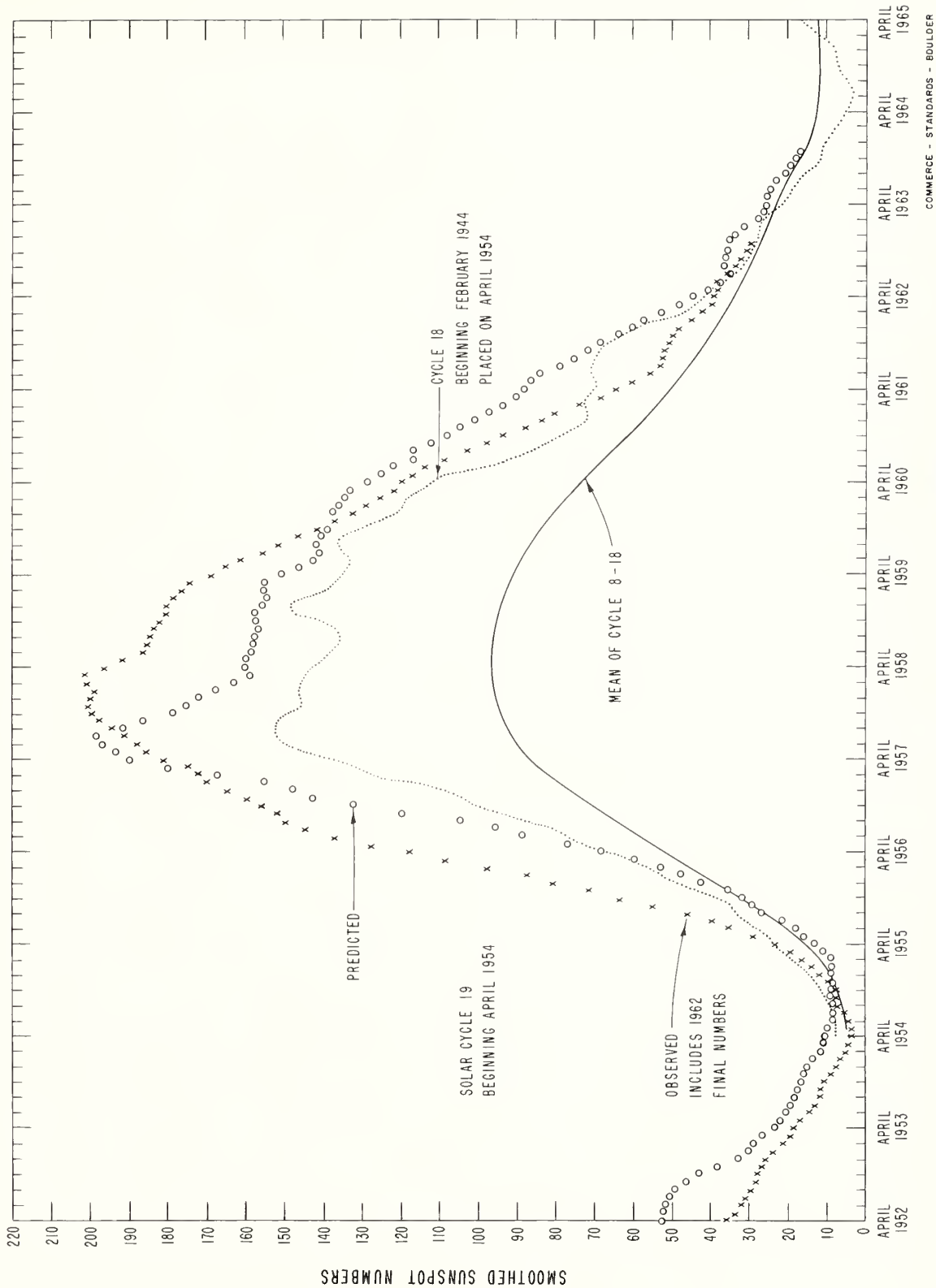


FIG. A PREDICTED AND OBSERVED SUNSPOT NUMBERS

TABLE I

TIME VARIATION

Harmonic	O		I	2	3	4	5	6	7	8
	K	S								
I	0	7.77910185E 00	2.3281898E 00	2.0629533E 00	-6.0080444E-01	3.3408295E-01	-1.3212476E-01	-4.8101287E-01	1.6779115E-01	-1.7095851E-01
	1	-3.5280302E-01	-1.6514334E-01	-5.9322708E-01	-5.5806721E-01	-5.8767921E-01	-1.0141881E 00	-1.0637937E 00	1.7228520E-01	-4.0074358E-01
	2	-3.9207768E 00	-4.4864634E 00	3.4098981E 00	2.4377729E 00	3.4098981E 00	-1.7178259E 00	-1.7178259E 00	1.0483362E 00	-2.0716184E 00
	3	-1.6592462E 00	-1.2226930E 01	3.2728850E 01	1.7968741E 01	1.7968741E 01	9.7088941E 00	8.1357021E 00	-1.474172E 00	-3.2621378E 00
	4	-6.8902736E 01	-2.9426705E 01	-6.0857090E 01	-1.917147E 01	-2.1176267E 01	2.4448482E 01	2.3733702E 01	-1.3482826E 01	-1.9891268E 01
	5	-2.1511830E 01	-1.1041391E 02	-1.5912623E 02	-9.8242364E 01	-9.8242364E 01	-4.457472E 01	-2.4250711E 01	9.0389786E 00	7.3094896E 01
	6	5.1511830E 01	1.1505096E 02	1.2501674E 02	1.2501674E 02	1.2501674E 02	5.7173595E 01	5.421133E 01	-1.6059274E 01	7.3094896E 01
	7	2.1511830E 01	1.1505096E 02	1.2501674E 02	1.2501674E 02	1.2501674E 02	5.7173595E 01	5.421133E 01	-1.6059274E 01	7.3094896E 01
	8	-2.1974638E 02	-2.0569129E 02	-1.9425481E 02	-3.0209888E 02	-7.6638020E 01	1.6133490E 01	1.3647501E 02	-1.1337533E 01	-1.4987758E 01
	9	-2.1974638E 02	-2.0569129E 02	-1.9425481E 02	-3.0209888E 02	-7.6638020E 01	1.6133490E 01	1.3647501E 02	-1.1337533E 01	-1.4987758E 01
	10	3.2686591E 01	1.6553389E 02	1.1782633E 02	-3.4128881E 02	-1.8847531E 02	-3.3045602E 01	-3.694770E 02	1.374459E 01	5.518712E 01
	11	8.7946641E 01	9.802534E 01	1.6121566E 02	1.31466350E 01	6.2808414E 01	7.0518124E 00	-3.690594E 02	5.7508565E 02	2.015584E 02
	12	-1.0094932E 02	-5.0506087E 01	-2.8859792E 01	1.2014757E 02	-1.7485427E 01	3.8287767E 01	2.7655665E 01	-3.8907651E 01	-8.3811814E 01
II	13	-1.824040E-02	2.0465685E-03	-2.1173514E-01	2.1405764E-03	1.2765245E-01	9.9908258E-02	9.7081348E-02	-4.6012436E-02	-3.7275449E-02
	14	3.6936350E-02	7.0112735E-02	-3.0214058E-01	7.2343853E-02	2.1853857E-02	9.8742395E-02	6.7039279E-02	-5.65116994E-02	-7.8845570E-02
	15	4.6364472E-01	-1.7423058E-01	-1.5750505E 02	-1.2013474E 00	-1.1873757E 00	9.8742395E-02	5.1975768E-02	-5.65116994E-02	-7.8845570E-02
	16	-7.513312E-02	3.5981741E 00	1.5750505E 02	-1.2013474E 00	-1.1873757E 00	9.8742395E-02	5.1975768E-02	-5.65116994E-02	-7.8845570E-02
	17	5.8486316E 00	5.9479549E 00	-4.5076749E-01	-1.5301761E 00	-7.6208678E-02	-5.9461563E 00	3.3620135E 00	1.7780747E 00	1.0305763E 00
	18	1.9237167E 01	2.3632958E 01	1.0567174E 01	-2.1974868E 01	1.39550002E 01	-3.625478E 00	2.0752899E-01	2.3031133E 00	8.986265E-01
	19	2.6805468E 01	2.0489528E 01	2.5781404E 01	1.9216832E 01	1.0758114E 01	4.1883327E 01	4.7662577E-03	-1.0139819E 01	3.0490458E 00
	20	3.6159737E 01	-1.7984052E 01	5.4533169E 01	1.1672464E 01	3.2593946E 01	1.6611609E 01	-1.3490780E 01	-1.3490780E 01	-3.779501E 00
	21	-6.5722474E 01	-4.5933489E 01	3.4608474E 01	1.0526445E 02	6.3682307E-01	6.770570E 00	-8.680528E-01	1.3526905E 01	-6.1468933E 00
	22	-1.6108629E 02	-1.3375229E 02	5.6958543E 01	1.0526445E 02	6.3682307E-01	6.770570E 00	-8.680528E-01	1.3526905E 01	-6.1468933E 00
	23	-1.4218923E 02	-1.0838314E 02	1.0526445E 02	6.5677680E 01	3.3787898E 01	-2.9476239E 00	4.7845014E-01	5.7562504E 01	-2.0087549E 01
III	24	-1.1986378E 02	3.6241432E 01	1.7923504E 02	-8.8568132E 01	-7.6210021E 01	-1.2184439E 01	1.5488691E 01	6.4226253E 01	1.3433121E 01
	25	-1.3566597E 02	1.0503002E 02	-1.6043374E 02	-8.0758257E 01	-7.3015672E-01	-1.0979710E 01	-1.5932064E 01	3.5134595E 01	1.8233406E 01
	26	4.2400137E 02	3.2867669E 02	1.1332269E 02	7.1455747E 01	7.4007782E 01	9.445234E 00	1.680030E 01	1.3109720E 01	1.8233406E 01
	27	2.6081400E 02	1.8287511E 02	2.3567032E 02	6.5786374E 01	4.2837005E 01	1.959579E 02	1.680030E 01	1.3109720E 01	1.8233406E 01
	28	-1.5197271E 02	-8.014355E 01	2.5126916E 02	6.5786374E 01	4.2837005E 01	1.959579E 02	1.680030E 01	1.3109720E 01	1.8233406E 01
	29	-1.5197271E 02	-8.014355E 01	2.5126916E 02	6.5786374E 01	4.2837005E 01	1.959579E 02	1.680030E 01	1.3109720E 01	1.8233406E 01
	30	-1.5197271E 02	-8.014355E 01	2.5126916E 02	6.5786374E 01	4.2837005E 01	1.959579E 02	1.680030E 01	1.3109720E 01	1.8233406E 01
	31	-1.5197271E 02	-8.014355E 01	2.5126916E 02	6.5786374E 01	4.2837005E 01	1.959579E 02	1.680030E 01	1.3109720E 01	1.8233406E 01
	32	-2.794175E 02	-1.3452459E 02	-8.12262765E 01	1.3208988E 01	1.02588851E 02	6.0354307E 00	9.8635340E-01	-3.1171492E 01	-2.4069594E 01
	33	-6.3223305E 01	1.3078198E 01	-1.0557568E 01	-3.7066105E 01	-2.1233355E 01	-8.0657868E 00	-4.5351121E 02	1.3122037E 02	-2.482553E 01
	34	5.9284805E 01	2.3620929E 01	1.2579861E 02	-3.2747465E 01	-2.3634522E 00	8.4242741E-01	-1.6074217E-01	1.1780636E 00	3.8237948E 00
	35	1.7505976E 02	1.4352887E 02	3.0400439E 01	-6.5587515E 01	-3.4616376E 01	3.4261340E 00	-3.642307E-01	1.2056203E 01	1.0856526E 01
	36	6.0959066E 01	2.8861704E 01	6.1927791E 00	-6.1478477E 00	2.1650664E 00	2.8323885E 00	1.5350499E 00	-4.6332172E 01	-2.4475559E 01

GEOGRAPHICAL VARIATION

Harmonic	K		S	5	6	7	8
I	0	6.46500520E-02	2.5765518E-01	-1.0779863E-01	-3.8690850E-02	-7.4839501E-03	-1.1085034E-01
	1	1.1774521E-01	1.0592216E-01	2.2902394E-01	-1.1965094E-02	2.4902394E-01	-5.7802591E-02
	2	-2.2809140E-01	-8.4415542E-01	2.5617818E-01	4.4867634E-01	4.4867634E-01	4.876511E-01
	3	-9.6395062E-02	-1.4444683E-01	2.4119160E-02	-2.7119244E-01	1.6445319E-01	6.9930247E-02
	4	1.74713555E-01	5.8729841E-01	-1.2772181E-01	-9.4643703E-02	-3.5068698E-01	-3.5068698E-01
	0	6.46500520E-02	2.5765518E-01	-1.0779863E-01	-3.8690850E-02	-7.4839501E-03	-1.1085034E-01
	1	1.1774521E-01	1.0592216E-01	2.2902394E-01	-1.1965094E-02	2.4902394E-01	-5.7802591E-02
	2	-2.2809140E-01	-8.4415542E-01	2.5617818E-01	4.4867634E-01	4.4867634E-01	4.876511E-01
	3	-9.6395062E-02	-1.4444683E-01	2.4119160E-02	-2.7119244E-01	1.6445319E-01	6.9930247E-02
	4	1.74713555E-01	5.8729841E-01	-1.2772181E-01	-9.4643703E-02	-3.5068698E-01	-3.5068698E-01
	0	6.46500520E-02	2.5765518E-01	-1.0779863E-01	-3.8690850E-02	-7.4839501E-03	-1.1085034E-01
	1	1.1774521E-01	1.0592216E-01	2.2902394E-01	-1.1965094E-02	2.4902394E-01	-5.7802591E-02
	2	-2.2809140E-01	-8.4415542E-01	2.5617818E-01	4.4867634E-01	4.4867634E-01	4.876511E-01
	3	-9.6395062E-02	-1.4444683E-01	2.4119160E-02	-2.7119244E-01	1.6445319E-01	6.9930247E-02
	4	1.74713555E-01	5.8729841E-01	-1.2772181E-01	-9.4643703E-02	-3.5068698E-01	-3.5068698E-01

I - Main latitudinal variation, Mixed latitudinal and longitudinal variation; II - First order in longitude, III - Second order in longitude

Notation: For each entry the number given by the first eight digits and sign is multiplied by the power of ten defined by the last two digits and sign.

PREDICTED COEFFICIENTS D_{SK} DEFINING THE FUNCTION $\Gamma(\lambda, \theta, t)$ FOR MONTHLY MEDIAN $f_0 F2$ (Mc/s) NOVEMBER 1963

TABLE 2

TIME VARIATION

Harmonic	O		I		2		3		4		5		6	
	K	S	K	S	K	S	K	S	K	S	K	S	K	S
I	0	3.0314663E 00	-1.0839111E-01	-2.9935335E-01	2.5566936E-02	-9.7841228E-02	2.5566936E-02	-9.7841228E-02	3.1126103E-02	-4.5951483E-02	3.1126103E-02	-4.5951483E-02	3.1126103E-02	-4.5951483E-02
	1	1.3657975E-01	6.1394201E-02	4.1577824E-02	5.3426457E-02	1.0780063E-01	5.3426457E-02	1.0780063E-01	-1.2616769E-01	-5.8312141E-02	-1.2616769E-01	-5.8312141E-02	-1.2616769E-01	-5.8312141E-02
	2	1.0059125E 00	6.3116307E-01	3.0994362E 00	2.0797633E-01	-2.596183E-03	2.0797633E-01	-2.596183E-03	4.7481229E-01	-1.4301944E-02	4.7481229E-01	-1.4301944E-02	4.7481229E-01	-1.4301944E-02
	3	6.4343557E-01	-1.8770203E-01	7.2173736E-01	-6.0903756E-01	-1.05666791E-01	-6.0903756E-01	-1.05666791E-01	4.5152375E-01	3.6947851E-02	4.5152375E-01	3.6947851E-02	4.5152375E-01	3.6947851E-02
	4	-2.4956528E 00	-1.1336037E 00	-8.0695171E-01	1.4716388E 00	3.0474482E-02	1.4716388E 00	3.0474482E-02	1.7773014E 00	1.0267371E-01	1.7773014E 00	1.0267371E-01	1.7773014E 00	1.0267371E-01
	5	-1.7453221E 00	3.6616818E-01	-8.8109728E-01	1.1490802E 00	9.0361203E-01	1.1490802E 00	9.0361203E-01	-5.9806244E-01	7.8876848E-02	-5.9806244E-01	7.8876848E-02	-5.9806244E-01	7.8876848E-02
	6	1.9266442E 00	8.5523981E-01	9.3304409E 00	2.4126359E 00	4.2505710E-01	2.4126359E 00	4.2505710E-01	-2.4351040E 00	7.6084673E-02	-2.4351040E 00	7.6084673E-02	-2.4351040E 00	7.6084673E-02
	7	1.0785711E 00	-2.40284928E-01	1.8950323E-01	-1.8129959E-01	-5.1337395E-01	-1.8129959E-01	-5.1337395E-01	2.5149192E-01	-7.1298050E-02	2.5149192E-01	-7.1298050E-02	2.5149192E-01	-7.1298050E-02
II	8	-3.8327936E-01	-1.9219587E-01	-4.0991526E 00	-1.2016784E 00	-3.3748093E-01	-1.2016784E 00	-3.3748093E-01	1.0984600E 00	-1.0890935E-01	1.0984600E 00	-1.0890935E-01	1.0984600E 00	-1.0890935E-01
	9	-3.0276643E-02	-2.6343459E-02	2.7535868E-02	-9.7203244E-03	6.2216275E-03	-9.7203244E-03	6.2216275E-03	2.3688783E-02	1.1361169E-02	2.3688783E-02	1.1361169E-02	2.3688783E-02	1.1361169E-02
	10	-6.9505881E-02	-1.7696407E-02	-6.4333326E-02	-2.6996591E-03	-6.0449526E-03	-2.6996591E-03	-6.0449526E-03	4.4504282E-02	-1.8063557E-03	4.4504282E-02	-1.8063557E-03	4.4504282E-02	-1.8063557E-03
	11	1.8780807E-01	-9.0059313E-02	1.6388221E-01	1.2393312E-02	1.2020803E-01	1.2393312E-02	1.2020803E-01	-2.8662669E-02	-8.7318472E-03	-2.8662669E-02	-8.7318472E-03	-2.8662669E-02	-8.7318472E-03
	12	-2.4846555E-01	-2.5402113E-01	-5.1321752E-01	1.6837955E-01	-2.9337604E-02	1.6837955E-01	-2.9337604E-02	9.9031582E-01	2.6783986E-02	9.9031582E-01	2.6783986E-02	9.9031582E-01	2.6783986E-02
	13	3.3387810E-01	1.4133444E-01	-5.5262599E-02	8.5112444E-02	-7.5160488E-02	8.5112444E-02	-7.5160488E-02	-3.6837027E-01	2.9639295E-01	-3.6837027E-01	2.9639295E-01	-3.6837027E-01	2.9639295E-01
	14	7.9581499E-01	2.1662166E-01	1.8376827E-01	2.0222852E-01	-4.8978305E-01	2.0222852E-01	-4.8978305E-01	5.8864165E-01	1.6215109E-01	5.8864165E-01	1.6215109E-01	5.8864165E-01	1.6215109E-01
	15	-1.0039904E 00	1.9946243E 00	-1.1542326E-01	-1.5026957E-01	-4.8978305E-01	-1.5026957E-01	-4.8978305E-01	3.1494929E-01	-9.5184928E-02	3.1494929E-01	-9.5184928E-02	3.1494929E-01	-9.5184928E-02
III	16	1.4183525E 00	1.9946243E 00	3.2791613E 00	-1.1073048E 00	-1.7913286E-01	-1.1073048E 00	-1.7913286E-01	-5.1946993E-02	-3.4406993E-02	-5.1946993E-02	-3.4406993E-02	-5.1946993E-02	-3.4406993E-02
	17	-8.8460430E-01	-2.5580337E-01	-3.4564527E-01	-2.0163480E-01	-4.0308912E-01	-2.0163480E-01	-4.0308912E-01	1.9289149E 00	-1.4110503E-01	1.9289149E 00	-1.4110503E-01	1.9289149E 00	-1.4110503E-01
	18	-3.0498885E 00	1.3666431E 00	1.567823E-01	-1.6406544E-01	1.0728392E 00	-1.6406544E-01	1.0728392E 00	2.1628551E 00	-7.9775591E-01	2.1628551E 00	-7.9775591E-01	2.1628551E 00	-7.9775591E-01
	19	1.5945348E 00	-2.1180202E-01	-3.5906176E-02	4.2084521E-01	6.5893035E-01	4.2084521E-01	6.5893035E-01	-8.7915788E-01	3.3174444E-01	-8.7915788E-01	3.3174444E-01	-8.7915788E-01	3.3174444E-01
	20	-2.7521779E 00	-4.3924479E-01	-5.980008E 00	2.3260092E-01	6.1826637E-01	2.3260092E-01	6.1826637E-01	9.3716657E-01	-1.3961236E-01	9.3716657E-01	-1.3961236E-01	9.3716657E-01	-1.3961236E-01
	21	6.2953384E-01	-9.0312432E-02	7.9435863E-01	3.5530373E-01	1.3838806E 00	3.5530373E-01	1.3838806E 00	-2.9111990E 00	1.3801949E 00	-2.9111990E 00	1.3801949E 00	-2.9111990E 00	1.3801949E 00
	22	4.6551403E 00	-3.4243087E 00	-1.9494513E-01	3.5192999E-01	-2.4921653E-01	3.5192999E-01	-2.4921653E-01	6.2177311E-01	-2.1480968E-01	6.2177311E-01	-2.1480968E-01	6.2177311E-01	-2.1480968E-01
	23	-7.682422E-01	-2.5649737E-02	8.0496111E-02	-3.1471578E-01	-4.0952221E-01	-3.1471578E-01	-4.0952221E-01	-5.4399968E-01	-1.6547073E-01	-5.4399968E-01	-1.6547073E-01	-5.4399968E-01	-1.6547073E-01
IV	24	1.6810617E 00	2.8557149E 00	3.5264929E-01	-1.4480098E-01	-4.0952221E-01	-1.4480098E-01	-4.0952221E-01	2.0230102E 00	-6.4479870E-01	2.0230102E 00	-6.4479870E-01	2.0230102E 00	-6.4479870E-01
	25	-4.988916E-02	3.4772146E-01	-3.1222369E-01	-1.6013068E-01	-9.1233617E-01	-1.6013068E-01	-9.1233617E-01	1.2787027E 00	-1.4451105E-01	1.2787027E 00	-1.4451105E-01	1.2787027E 00	-1.4451105E-01
	26	-2.4058113E 00	2.0940543E 00	1.5820379E 00	-2.1644443E 00	1.25533015E 00	-2.1644443E 00	1.25533015E 00	1.0186362E-02	-1.0860458E-03	1.0186362E-02	-1.0860458E-03	1.0186362E-02	-1.0860458E-03
	27	-3.2533263E-02	1.3839229E-03	6.4968337E-03	1.0211486E-02	7.7850901E-04	1.0211486E-02	7.7850901E-04	2.2451406E-02	7.8748343E-03	2.2451406E-02	7.8748343E-03	2.2451406E-02	7.8748343E-03
	28	-2.9949654E-02	-2.0003028E-02	2.5854755E-02	-3.3409815E-03	9.8884180E-03	-3.3409815E-03	9.8884180E-03	8.4680809E-03	-7.2616071E-03	8.4680809E-03	-7.2616071E-03	8.4680809E-03	-7.2616071E-03
	29	-1.5976381E-01	-1.0451976E-01	-6.9215851E-02	5.6553891E-02	-5.2398669E-02	5.6553891E-02	-5.2398669E-02	-7.2616071E-03	-3.0220355E-02	-7.2616071E-03	-3.0220355E-02	-7.2616071E-03	-3.0220355E-02
	30	3.0050568E-03	2.1590525E-02	-8.8737545E-02	5.2398669E-02	-5.03307715E-02	5.2398669E-02	-5.03307715E-02	1.5266437E-02	-2.4146727E-02	1.5266437E-02	-2.4146727E-02	1.5266437E-02	-2.4146727E-02
	31	8.4725537E-02	-6.8957541E-02	7.6382970E-02	-1.0232775E-02	-5.2074758E-02	-1.0232775E-02	-5.2074758E-02	-5.9199725E-02	-5.9199725E-02	-5.9199725E-02	-5.9199725E-02	-5.9199725E-02	-5.9199725E-02

Harmonic	4		5		6	
	K	S	K	S	K	S
I	0	4.4660211E-03	1.1834950E-02	3.2213355E-02	-1.4414817E-02	-5.1710034E-03
	1	7.3305504E-04	-9.0485159E-02	2.3767459E-02	-1.1110882E-02	2.8720576E-02
	2	-5.3760695E-03	-2.4899755E-02	-5.03307715E-02	2.7220232E-02	1.2284412E-02
	3	-1.2063927E-03	9.8858811E-02	-3.0067838E-02	1.5266437E-02	-2.4146727E-02

I - Main latitudinal variation. Mixed latitudinal and longitudinal variation: II - First order in longitude, III - Second order in longitude.
 Notation: For each entry the number given by the first eight digits and sign is multiplied by the power of ten defined by the last two digits and sign.

PREDICTED COEFFICIENTS D_{SK} DEFINING THE FUNCTION $I(\lambda, \theta, t)$ FOR MONTHLY MEDIAN $M(3000)F2$
 NOVEMBER 1963

NOVEMBER 1963 UT = 00

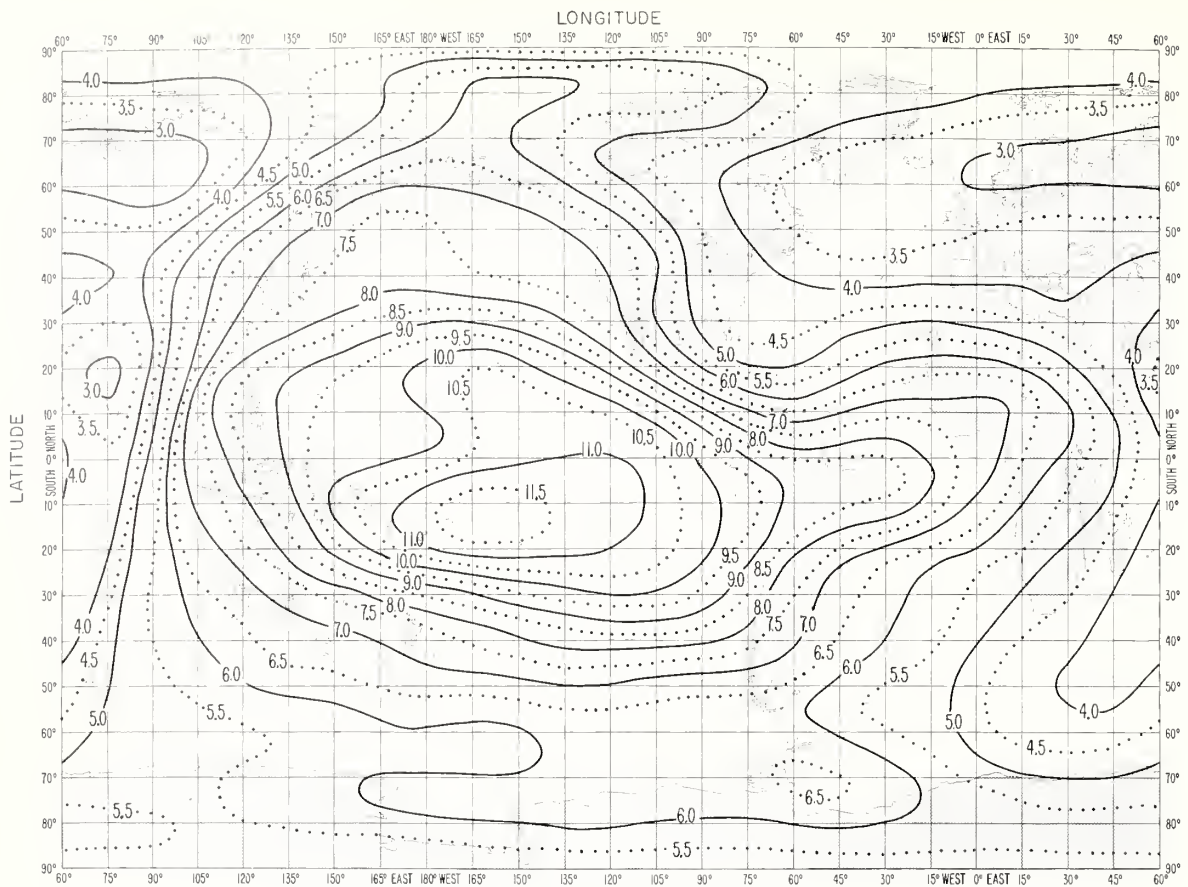


FIG 1A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

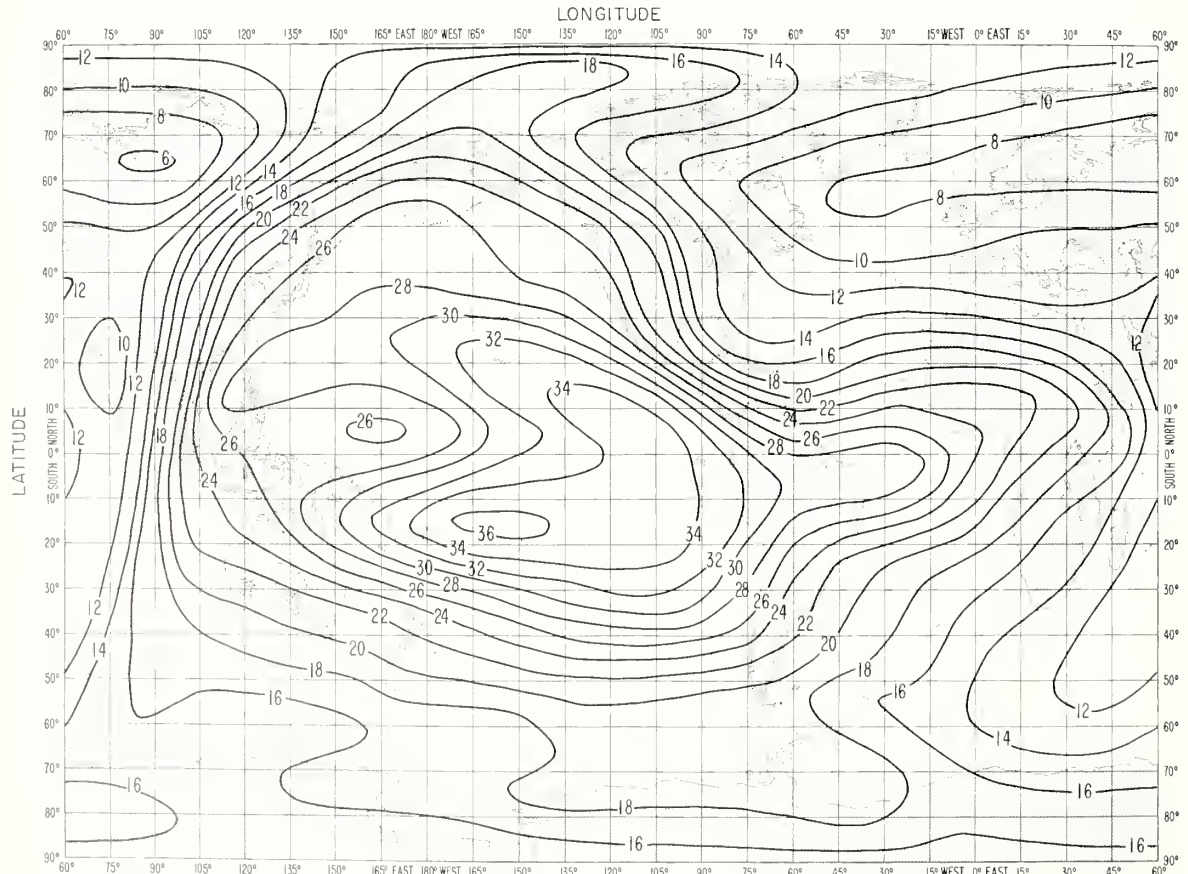
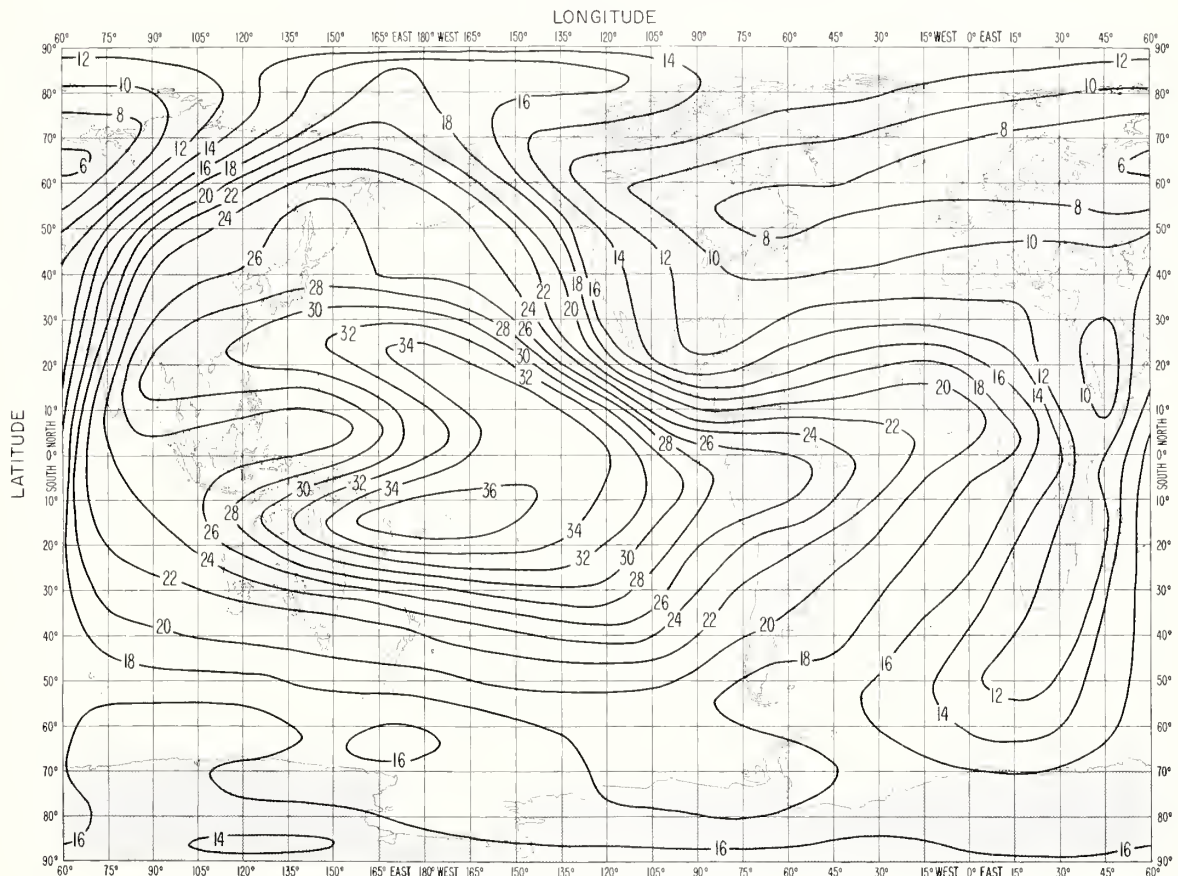
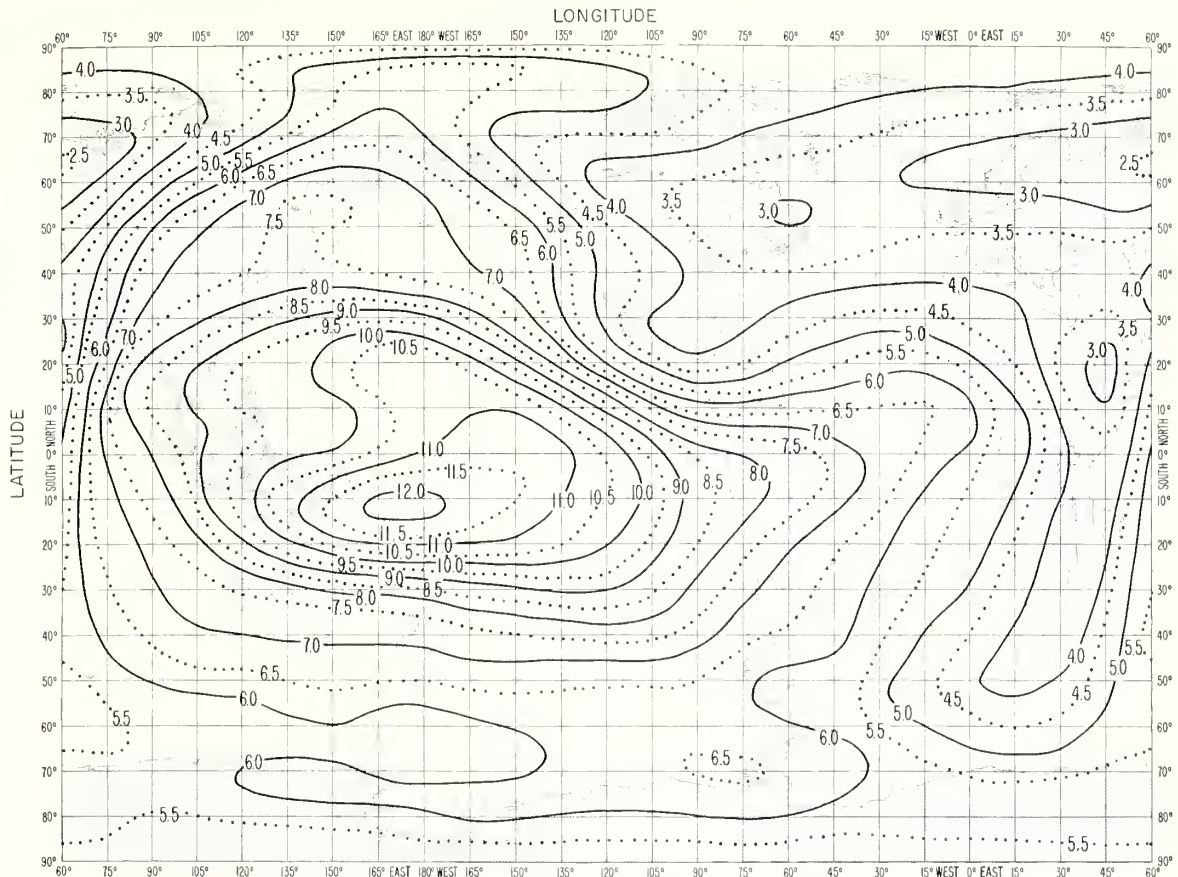


FIG 1B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

NOVEMBER 1963 UT=02



NOVEMBER 1963 UT = 04

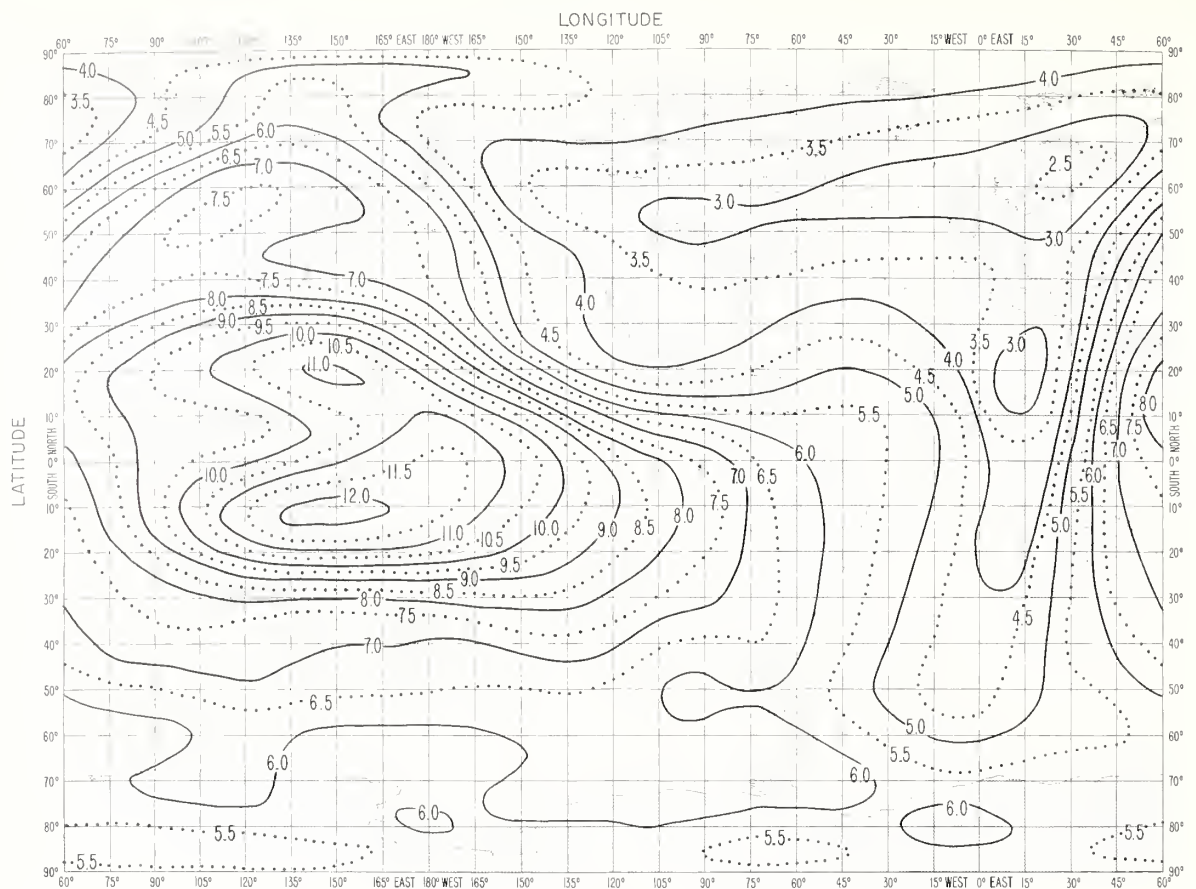


FIG. 3A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

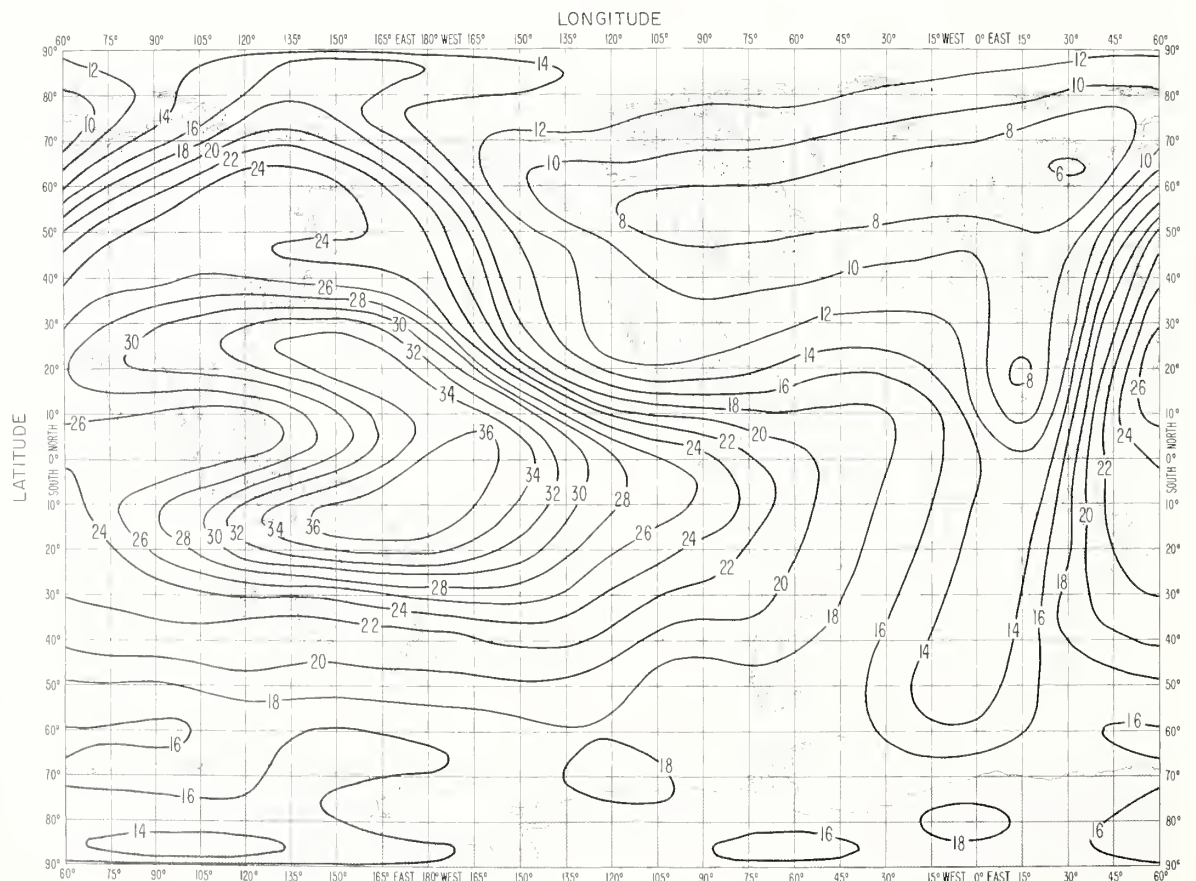
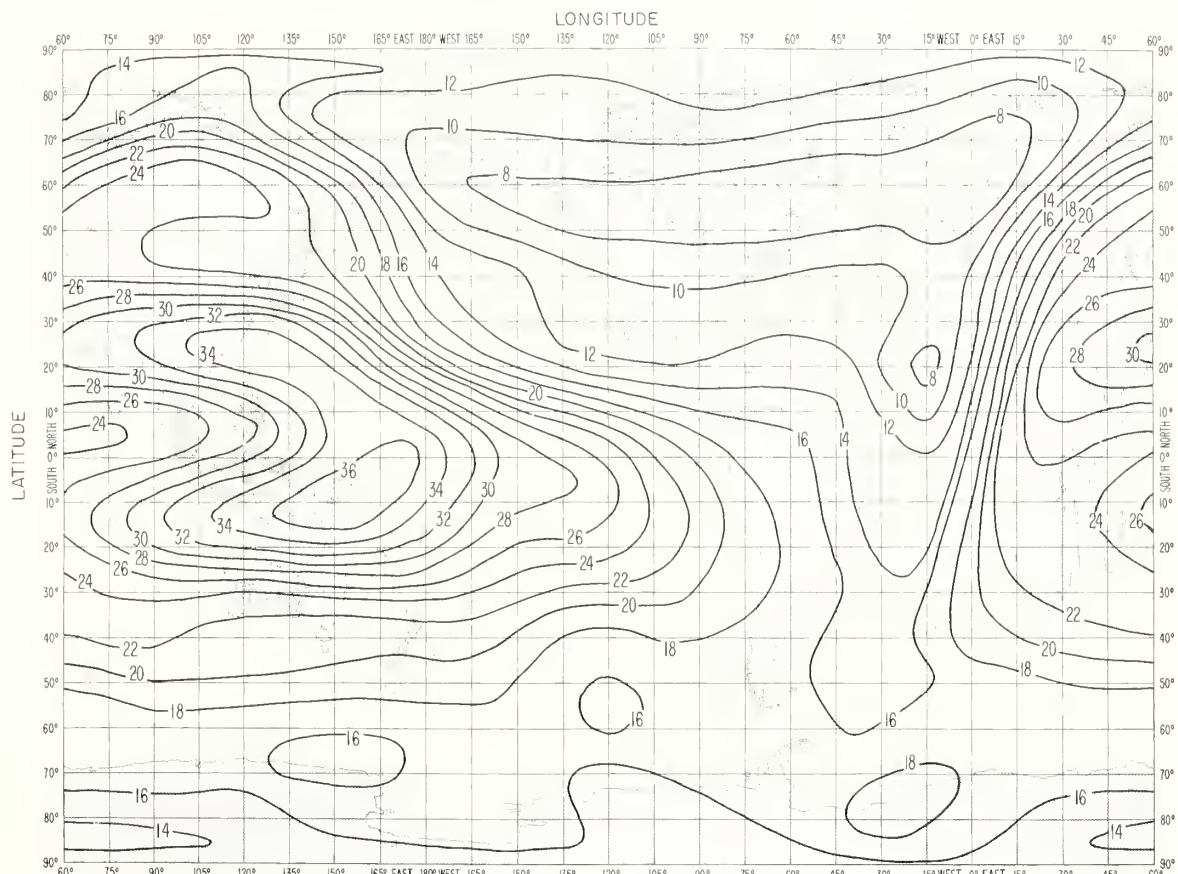
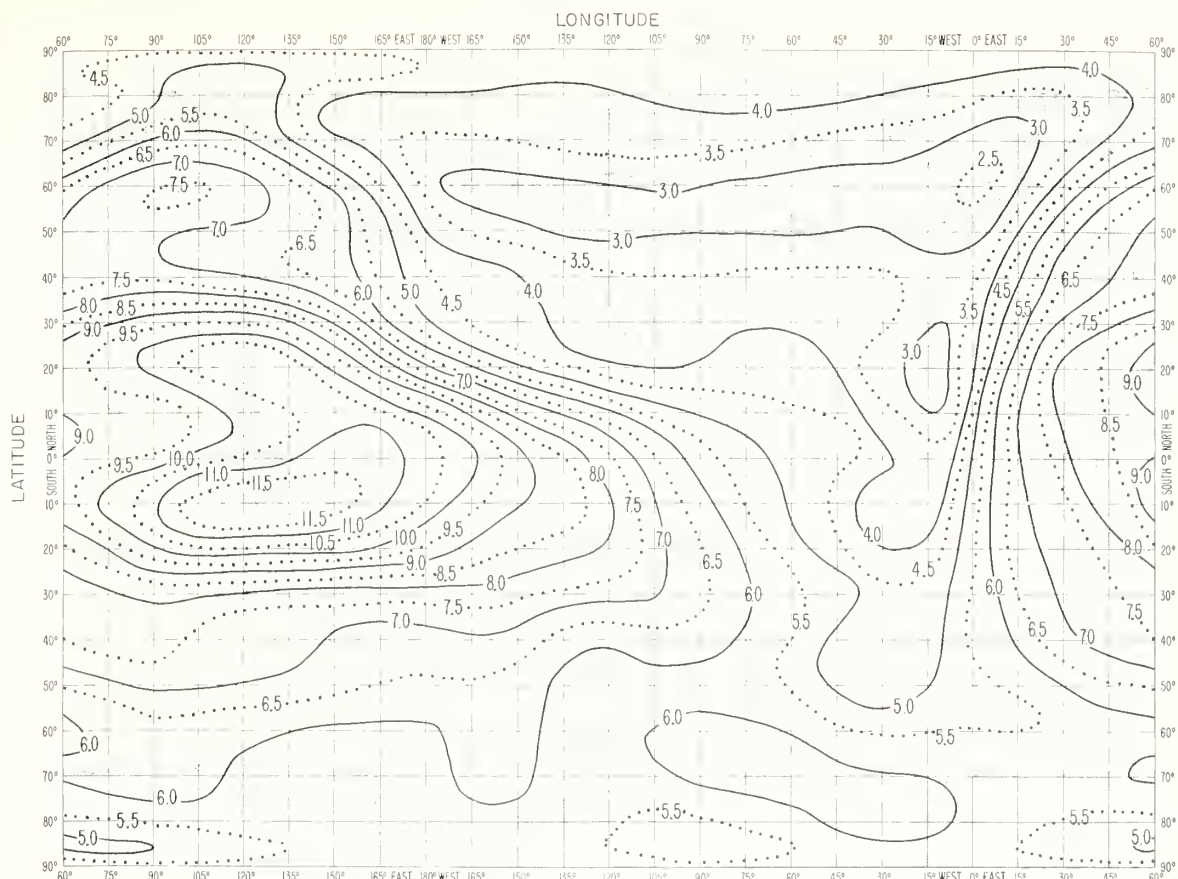
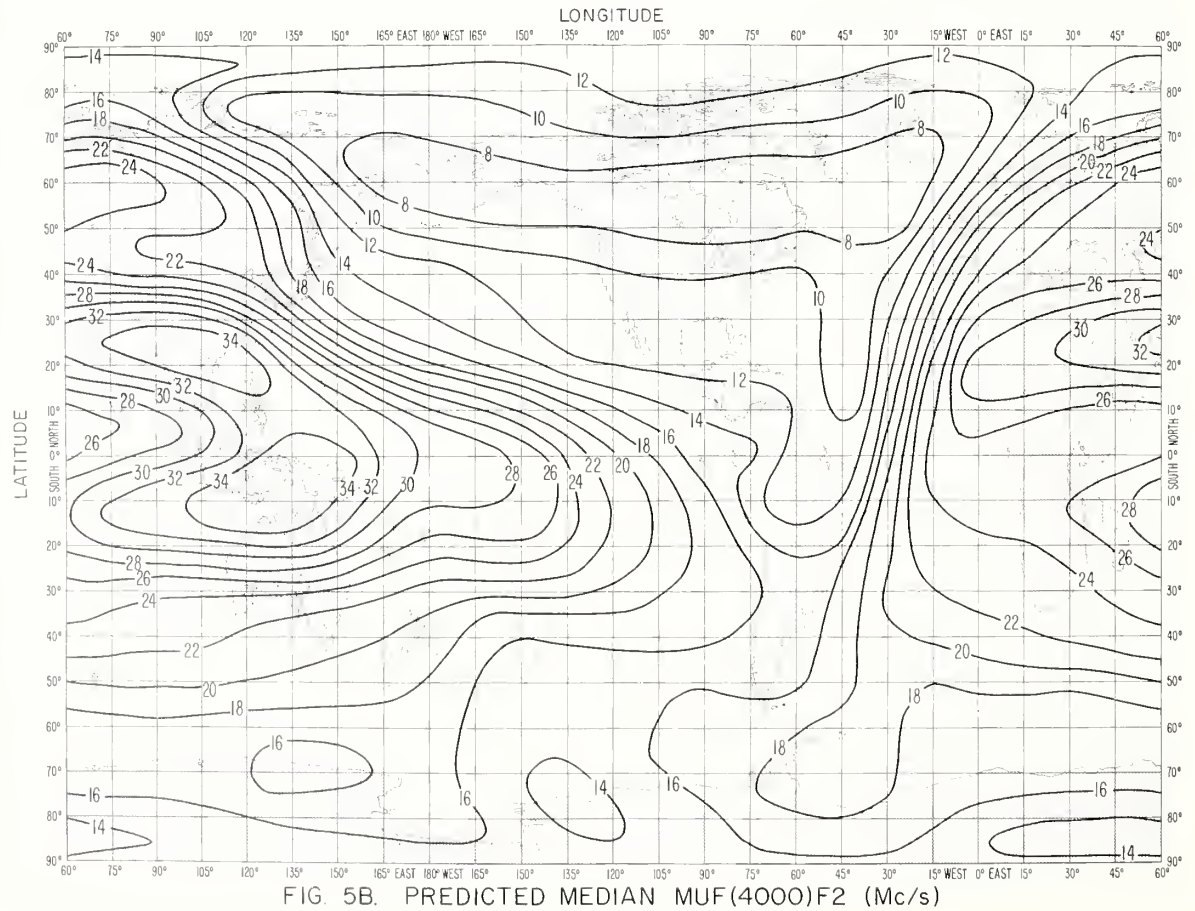
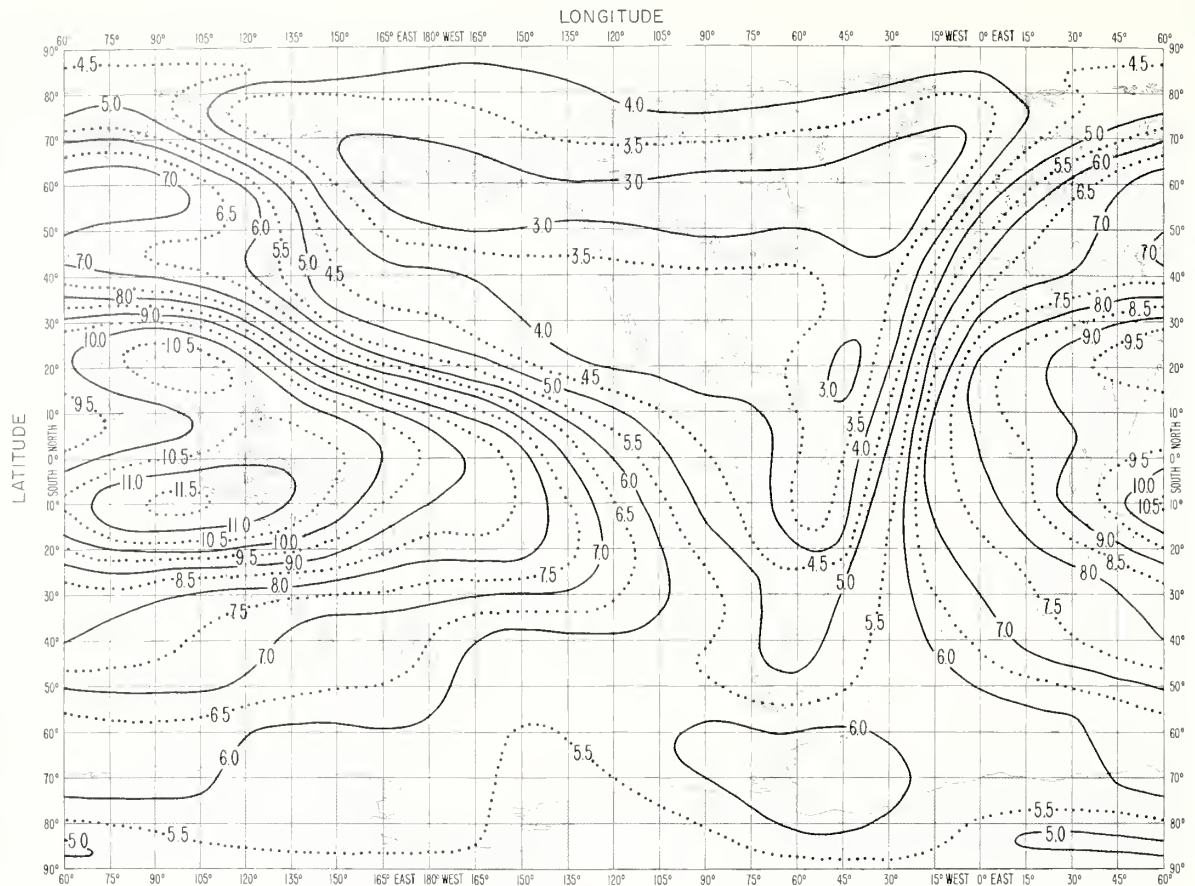


FIG. 3B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

NOVEMBER 1963 UT = 06





NOVEMBER 1963 UT = 10

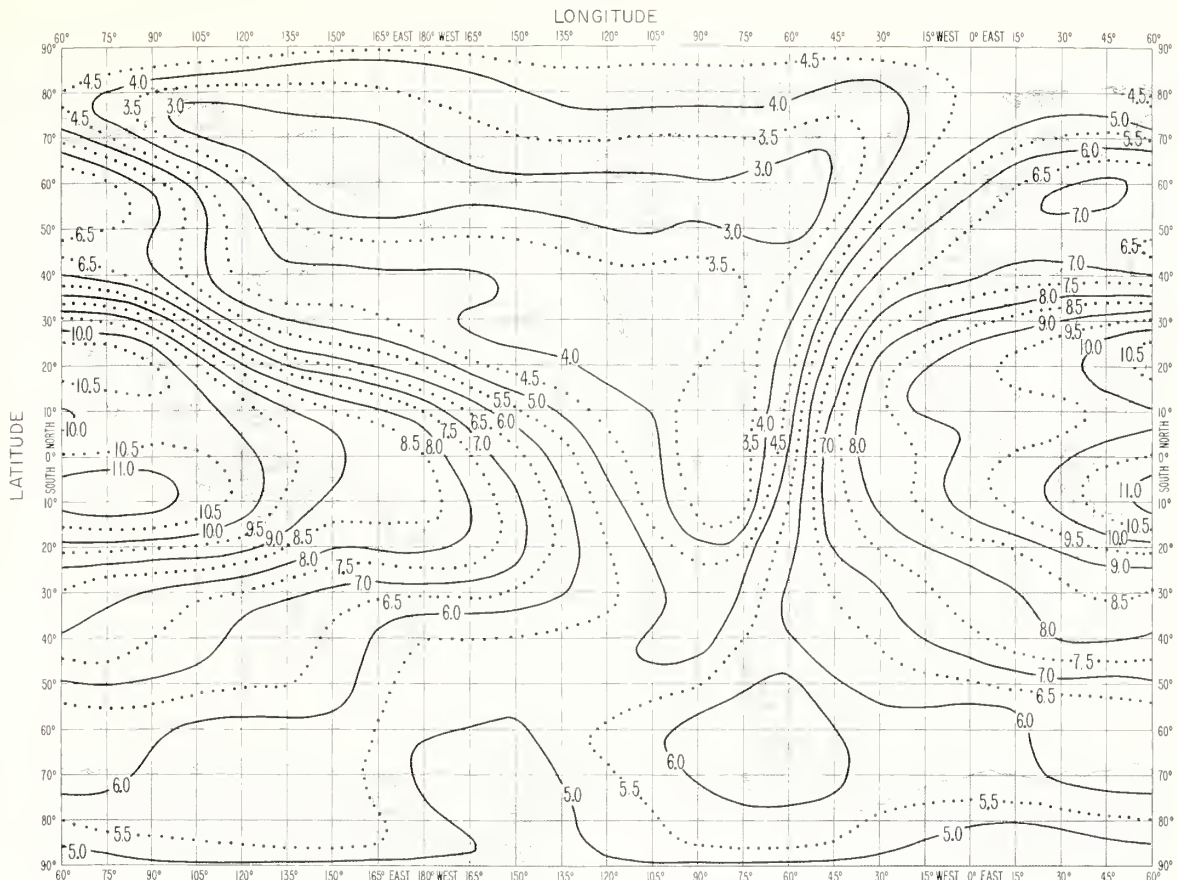


FIG. 6A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

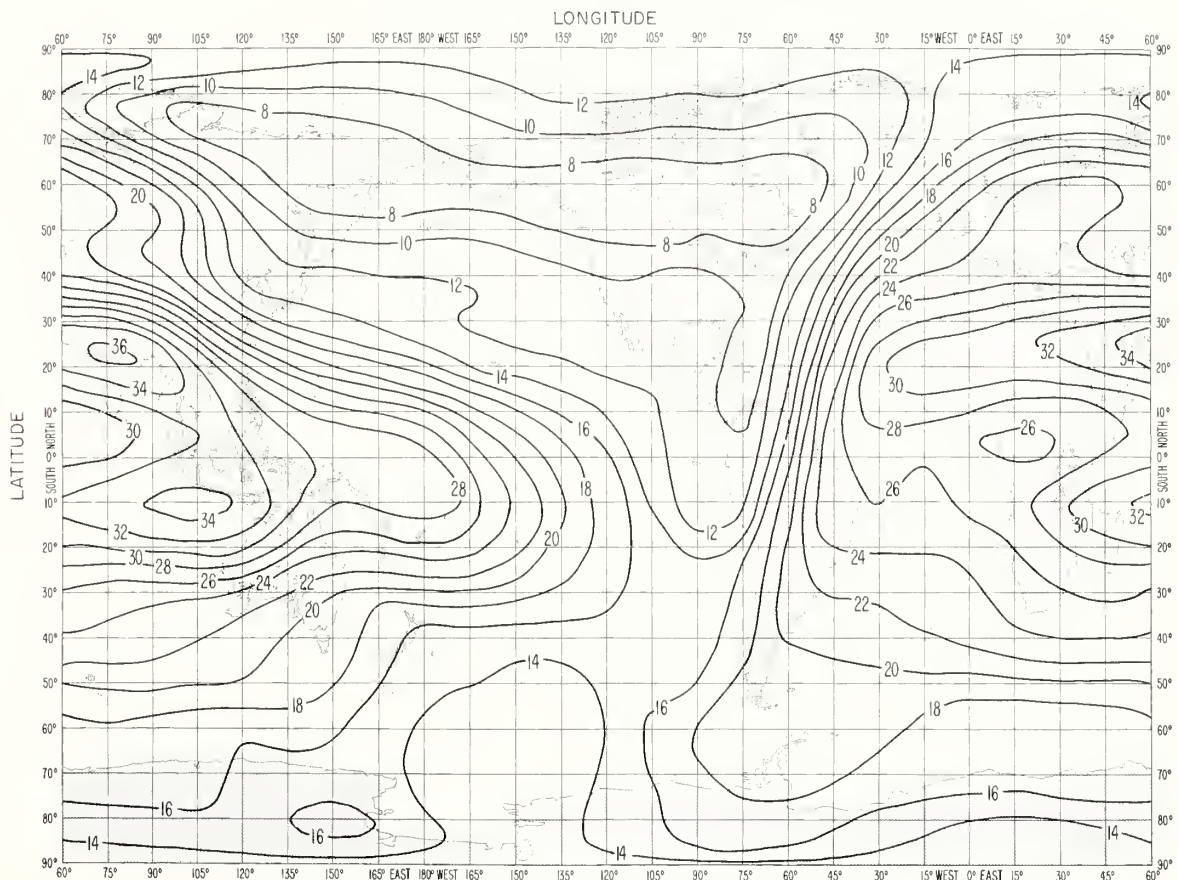


FIG. 6B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

NOVEMBER 1963 UT = 12

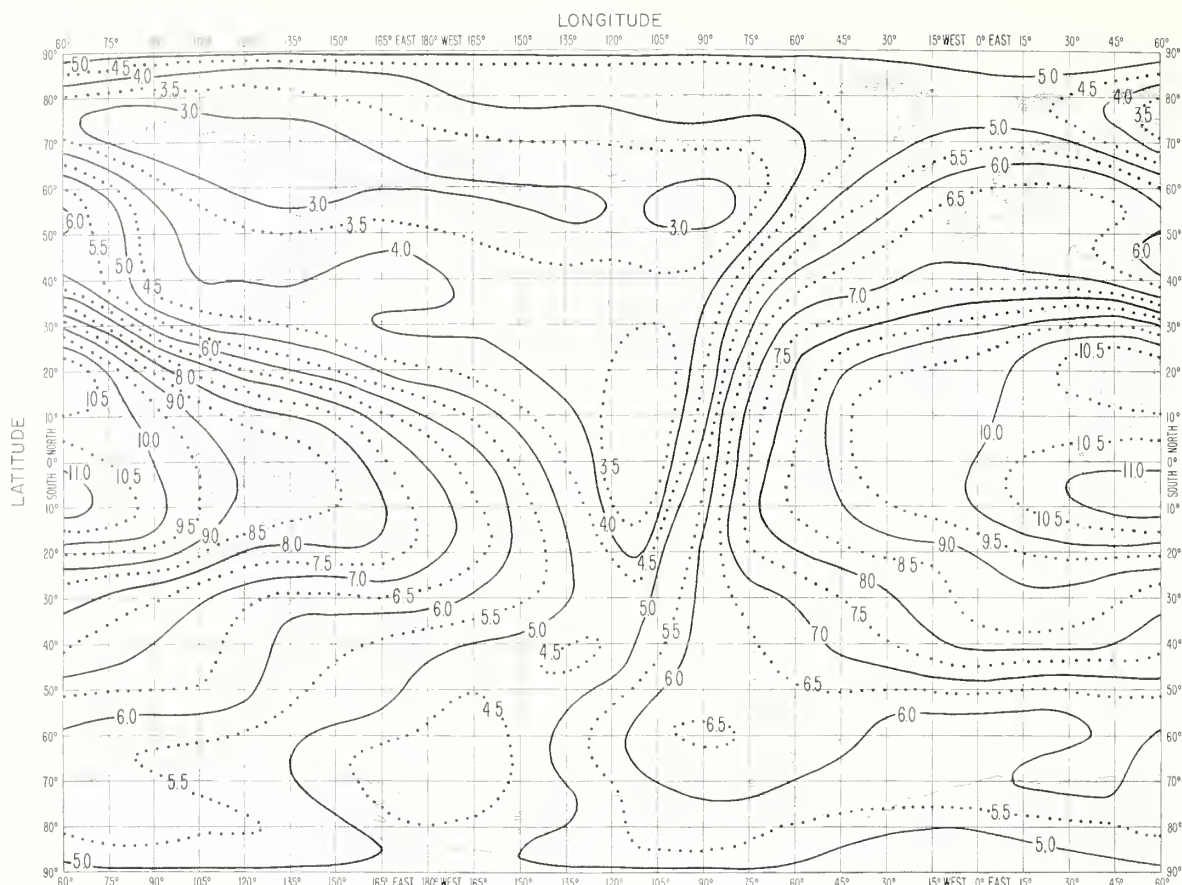


FIG 7 A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

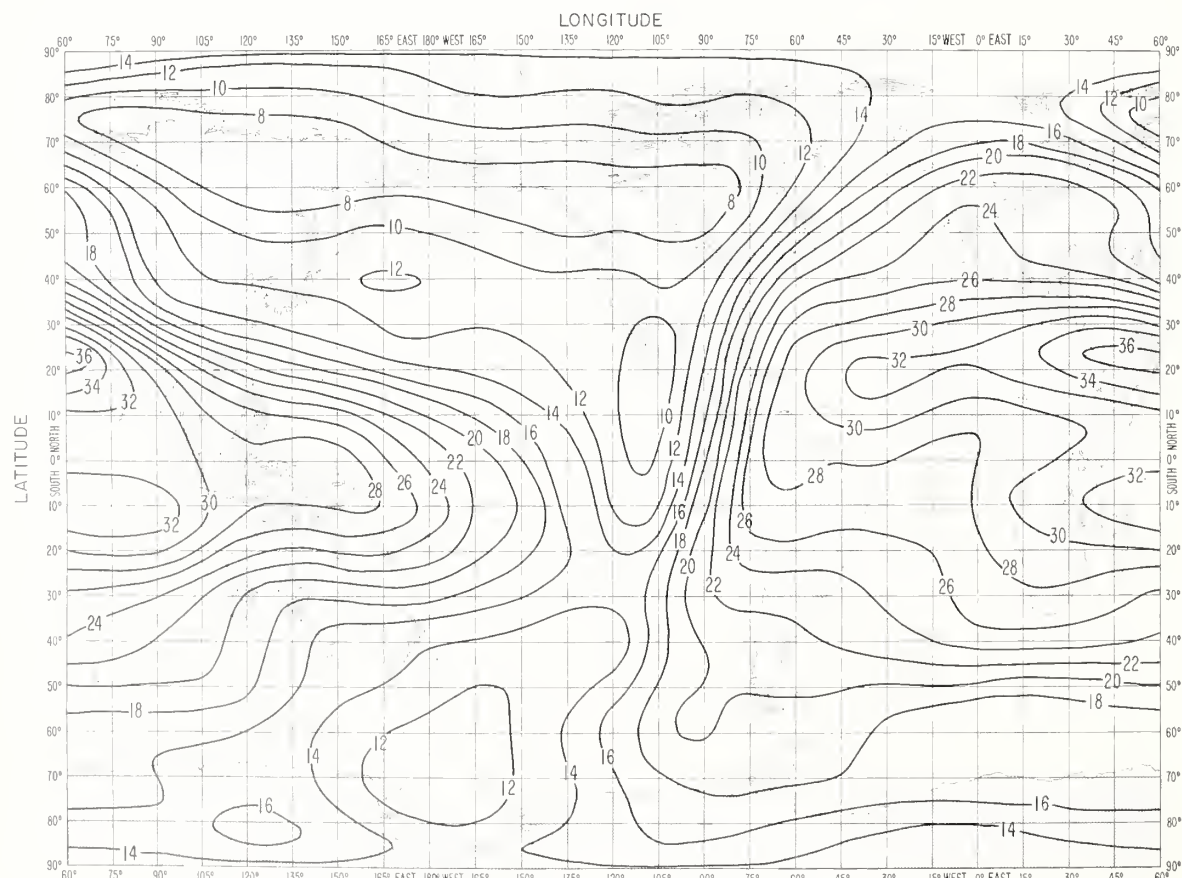


FIG 7 B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

NOVEMBER 1963 UT = 14

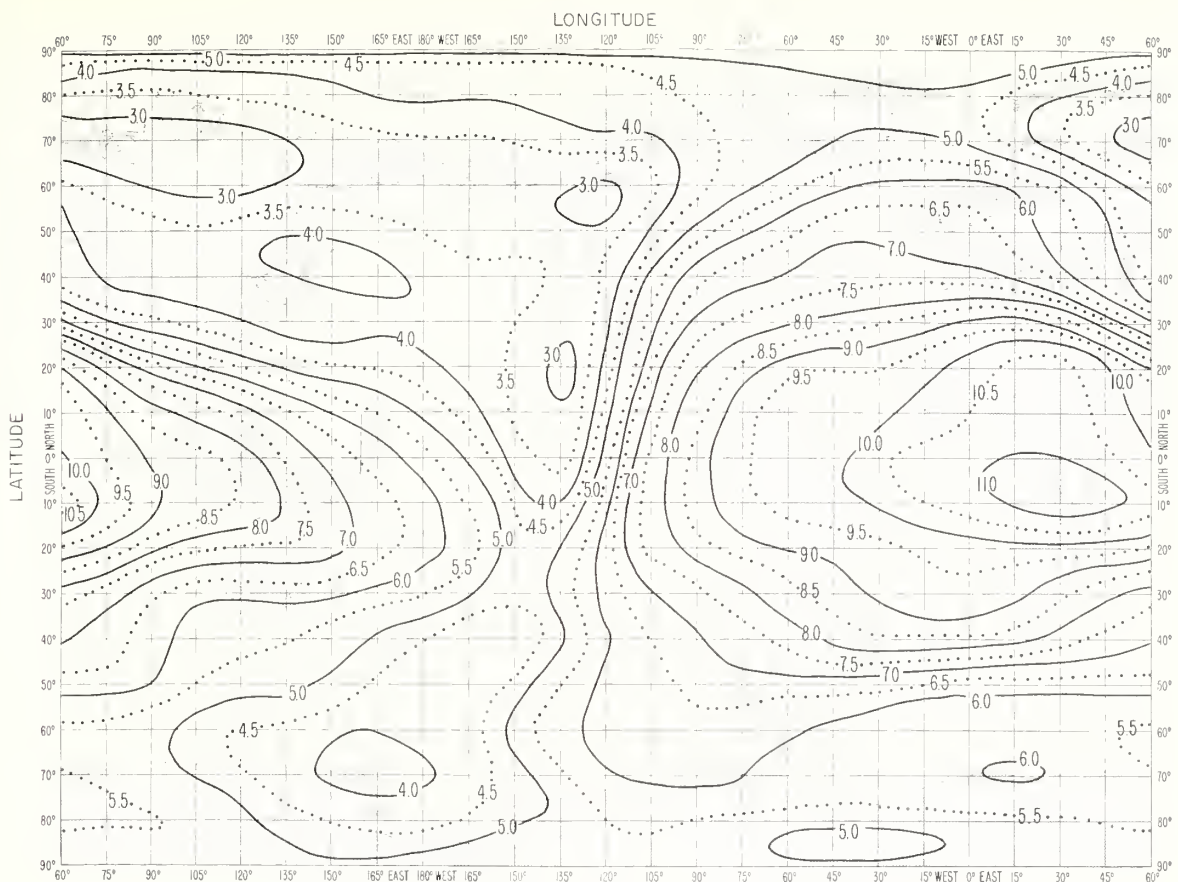


FIG. 8A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

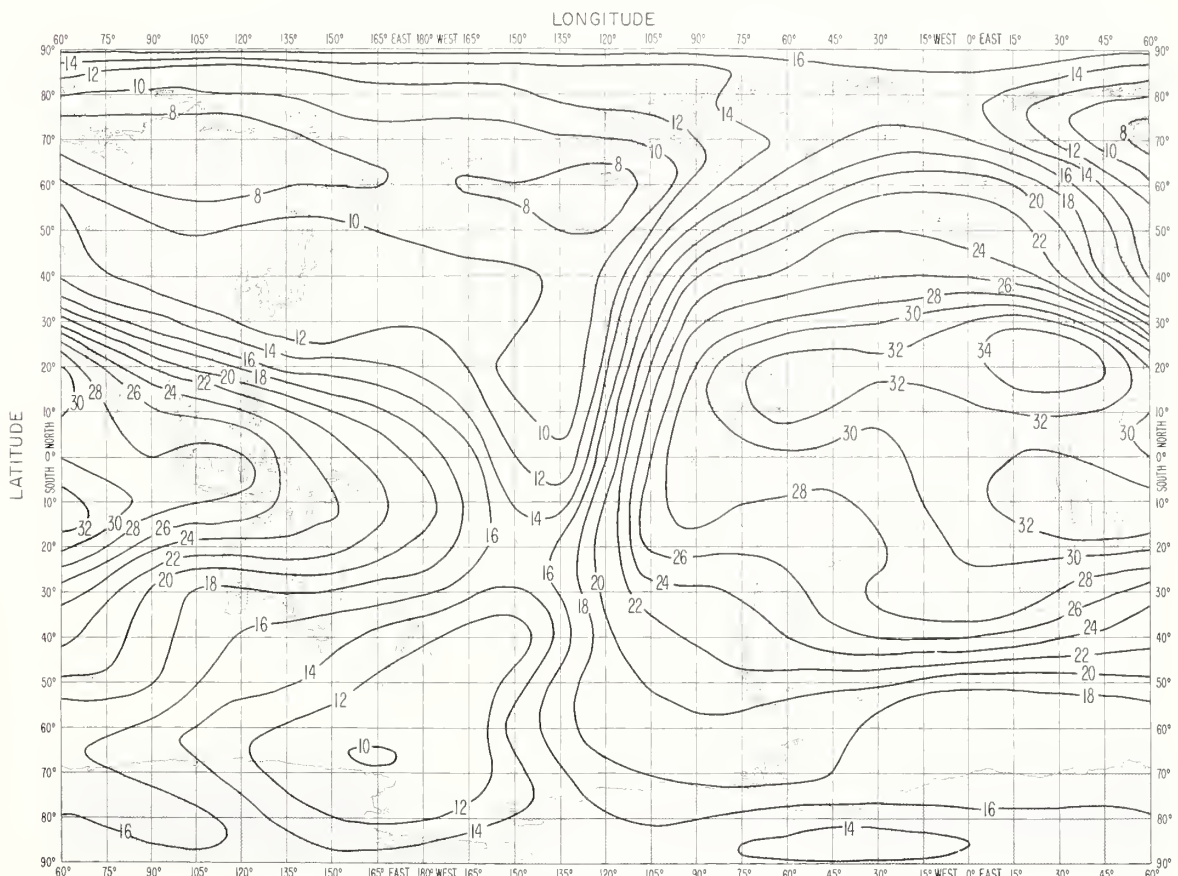


FIG. 8B PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

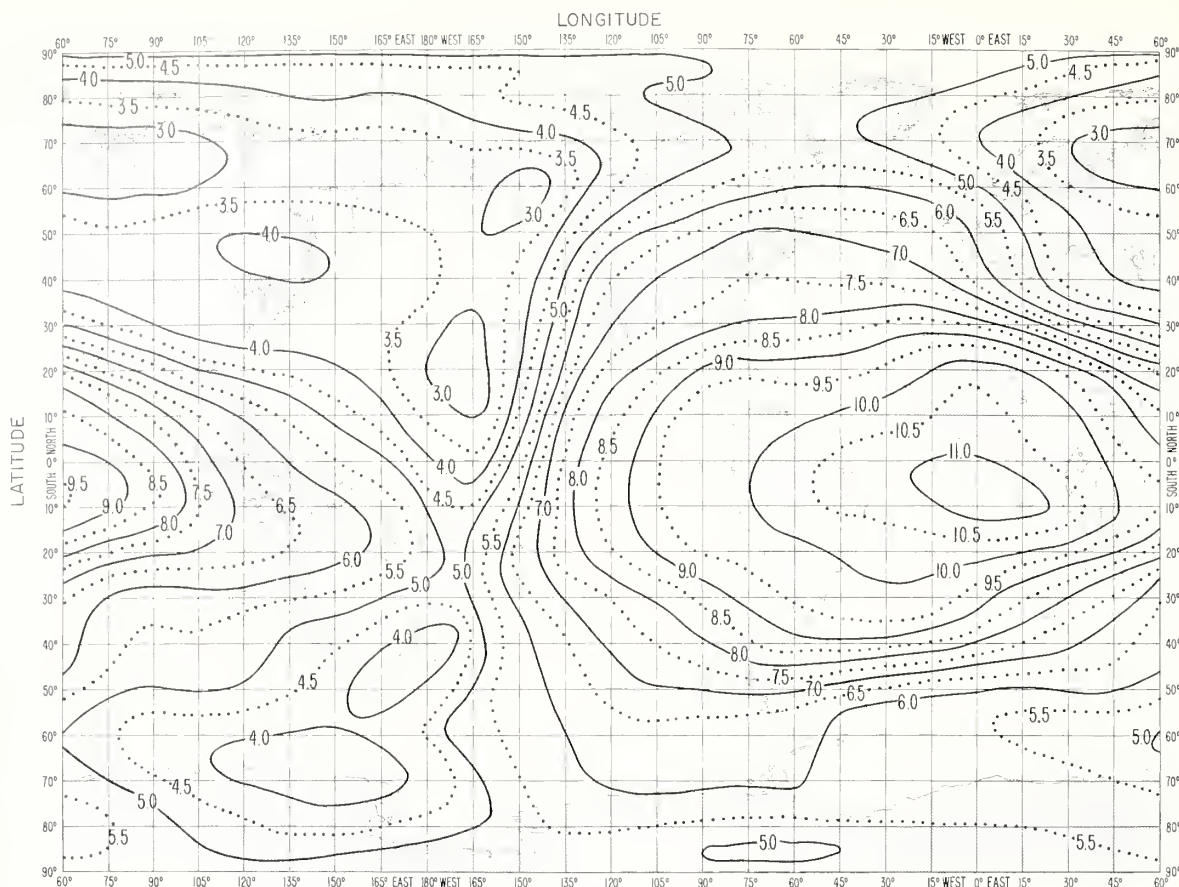


FIG. 9A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

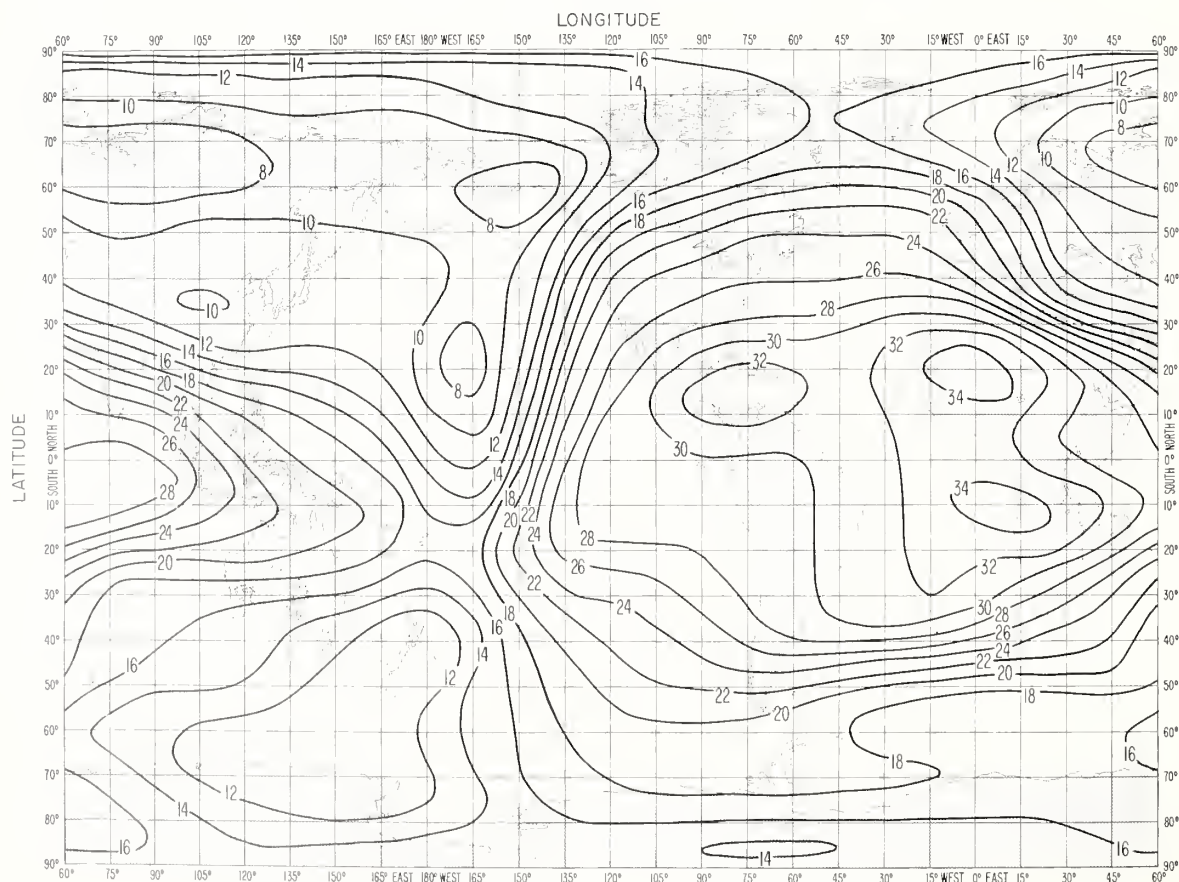
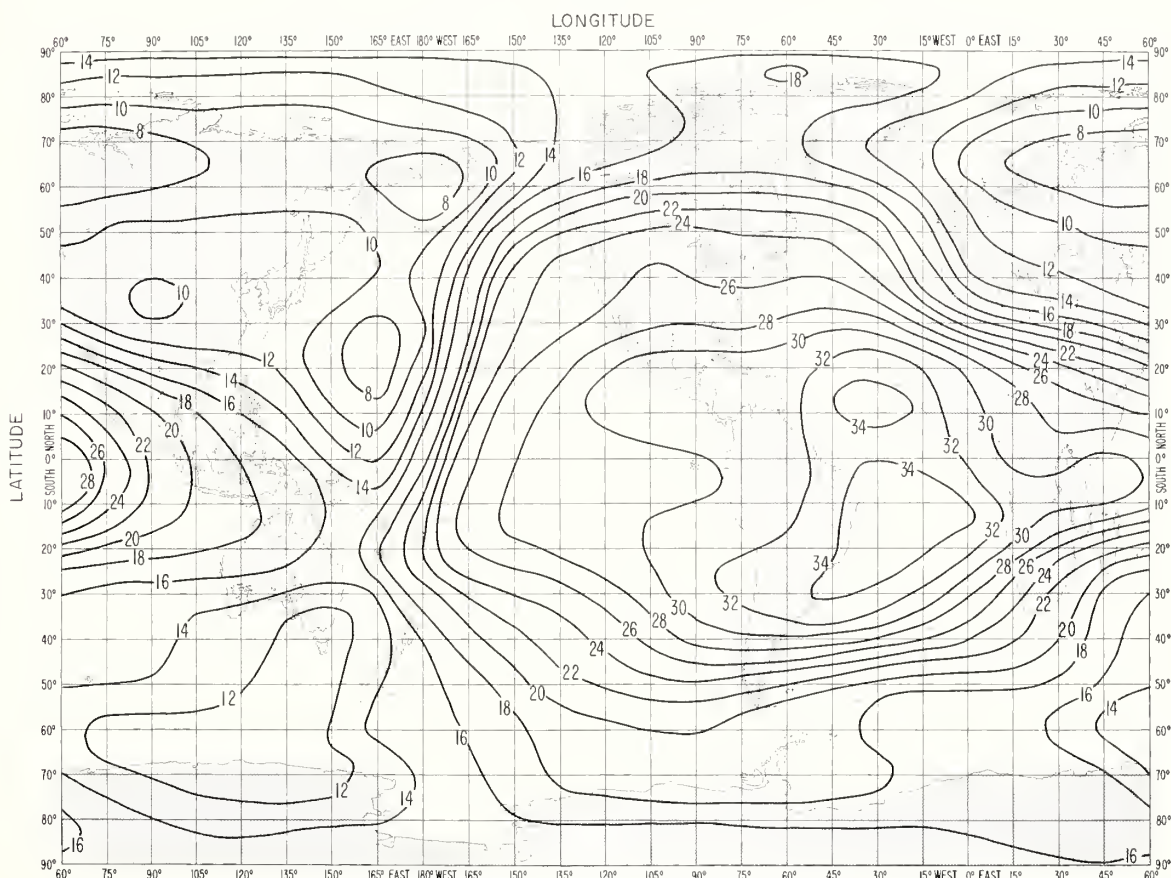
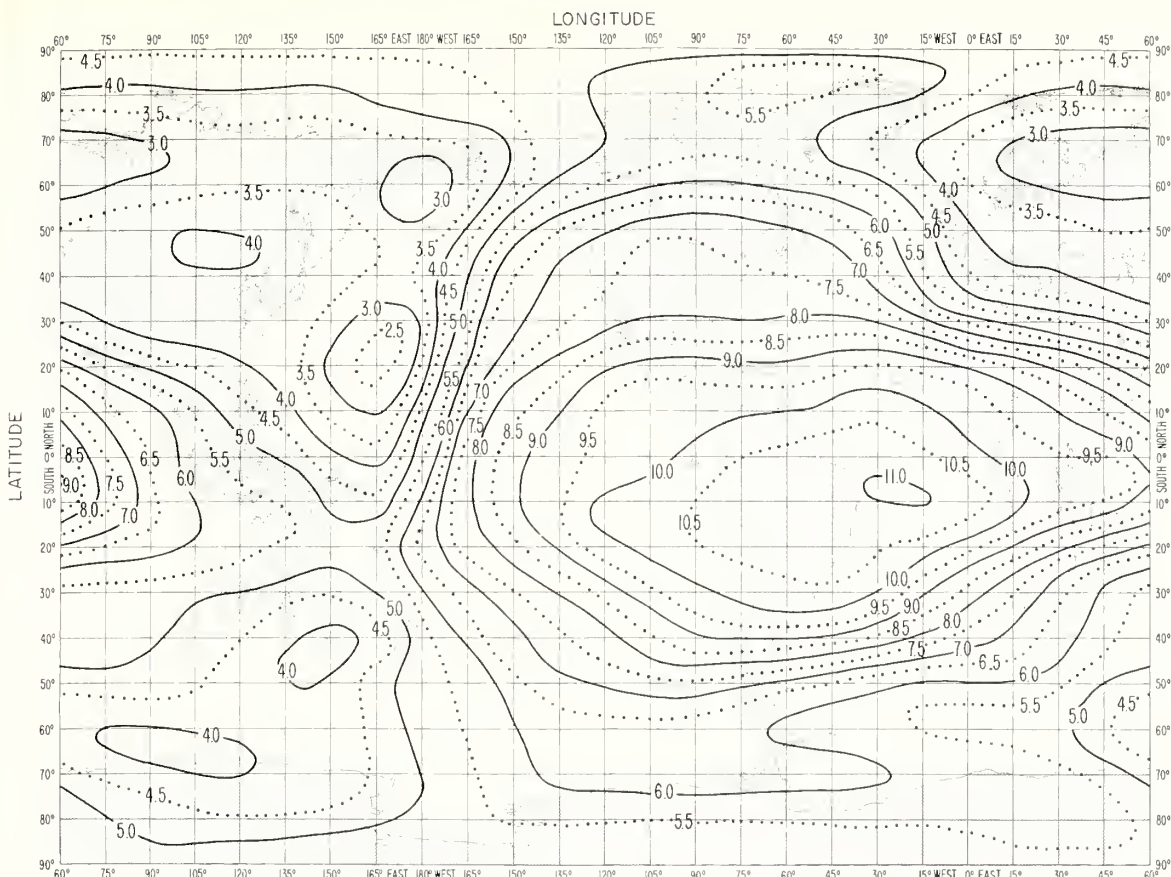
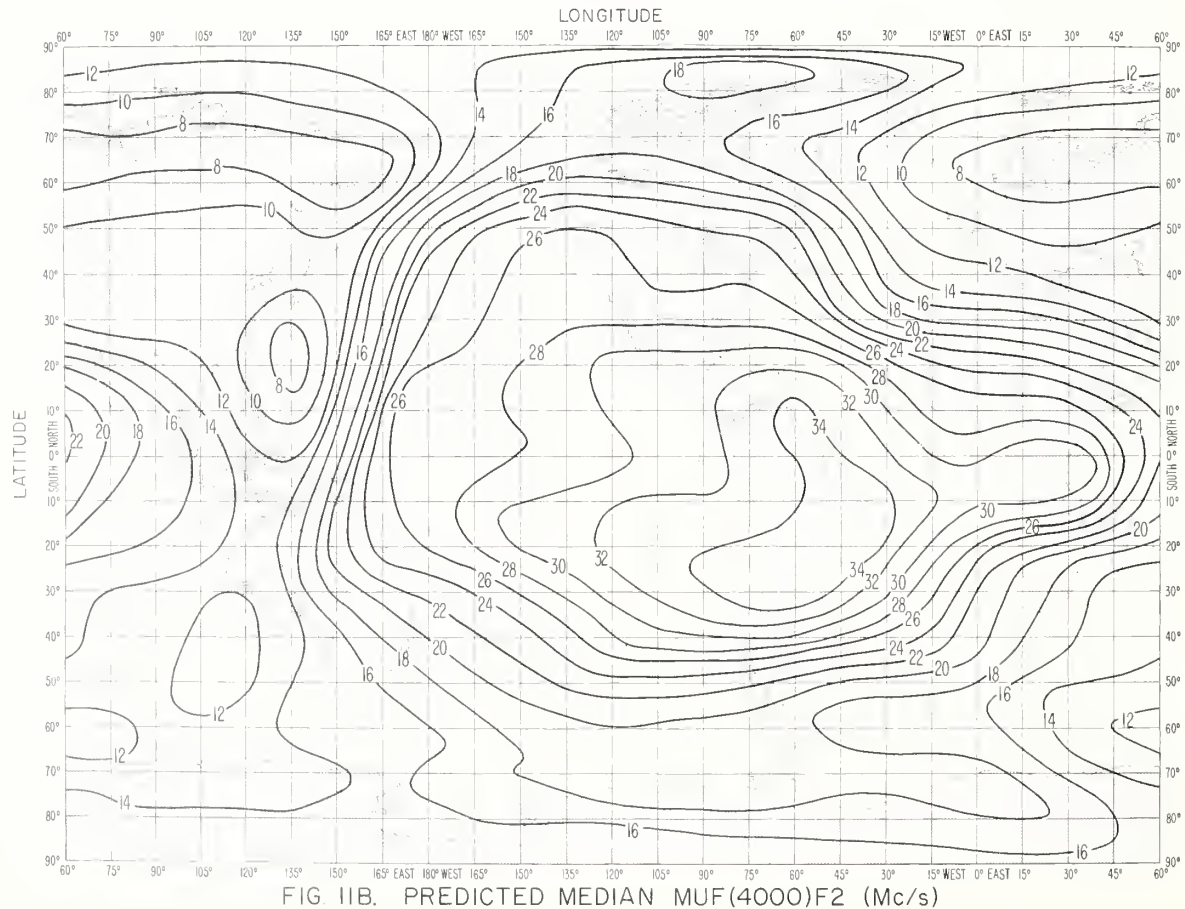
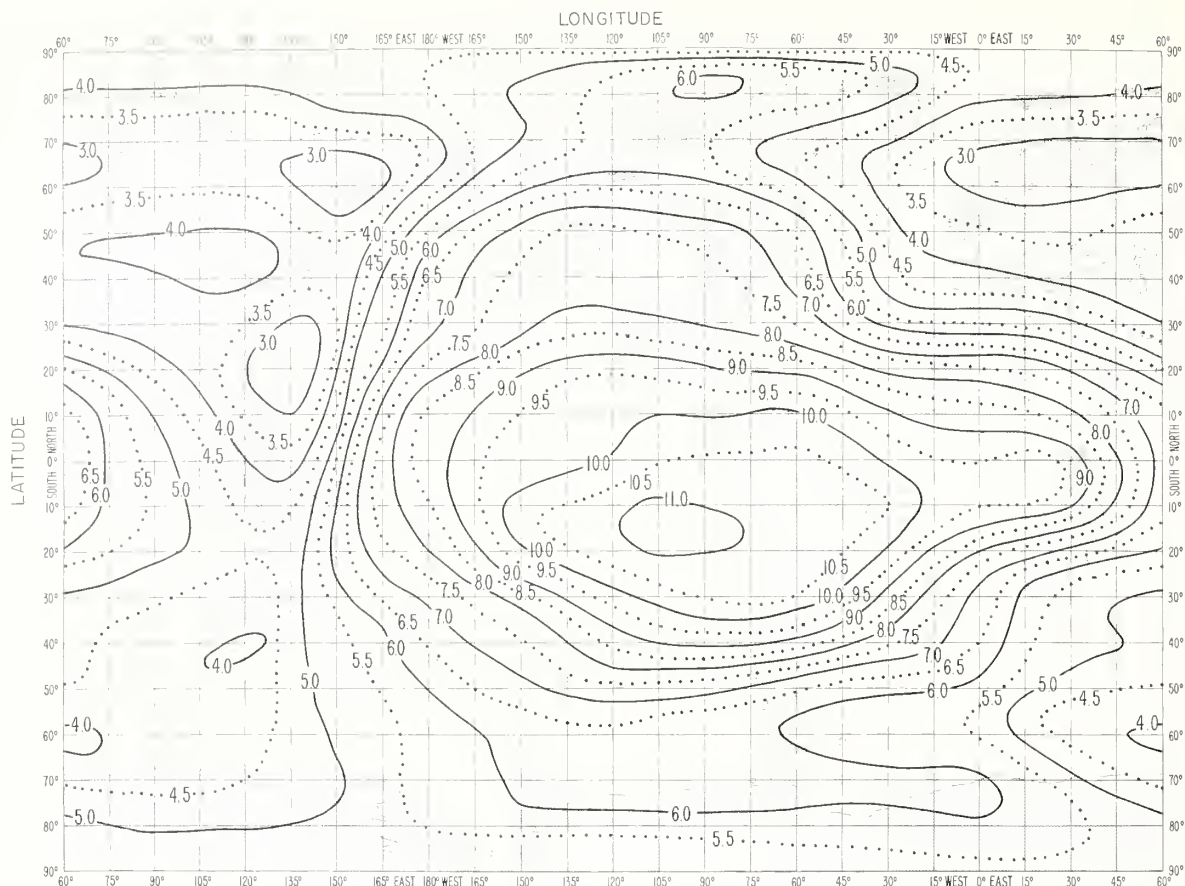


FIG. 9B PREDICTED MEDIAN MUF(4000)F2 (Mc/s)





NOVEMBER 1963 UT = 22

LONGITUDE

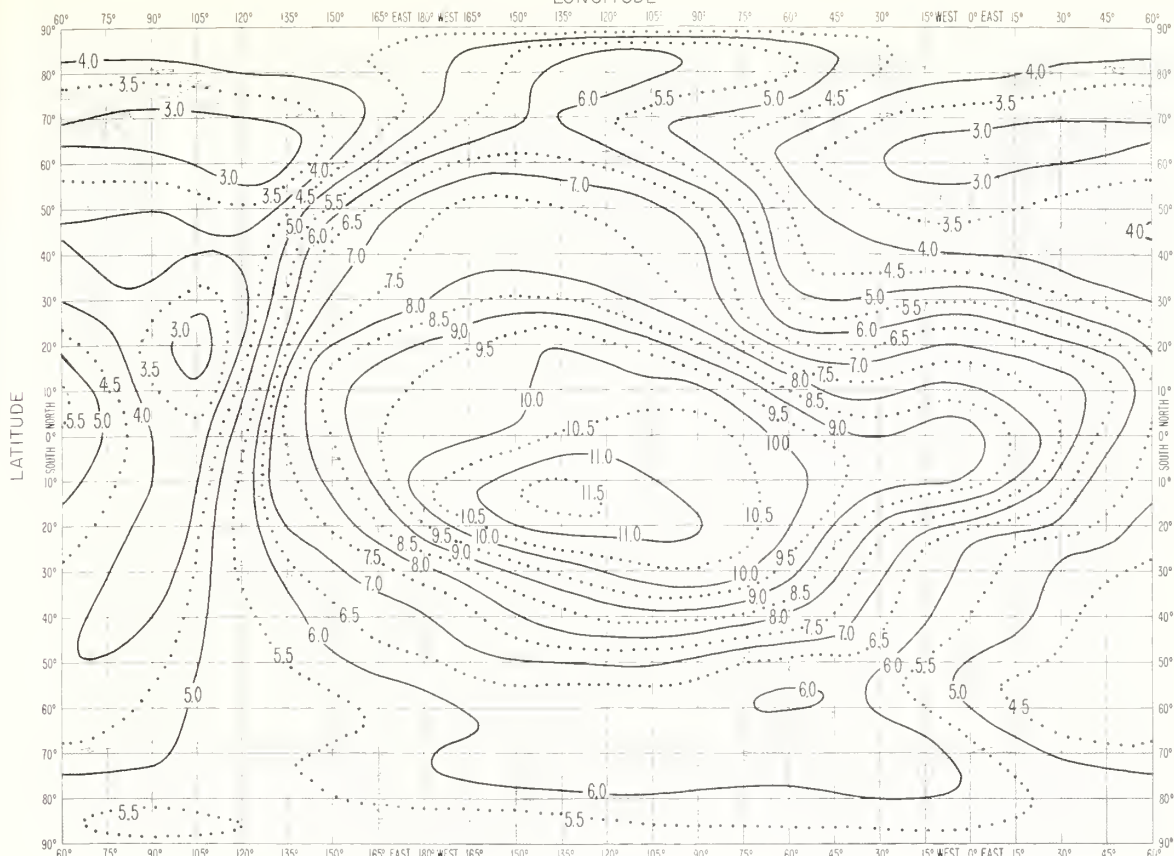


FIG I2A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

LONGITUDE

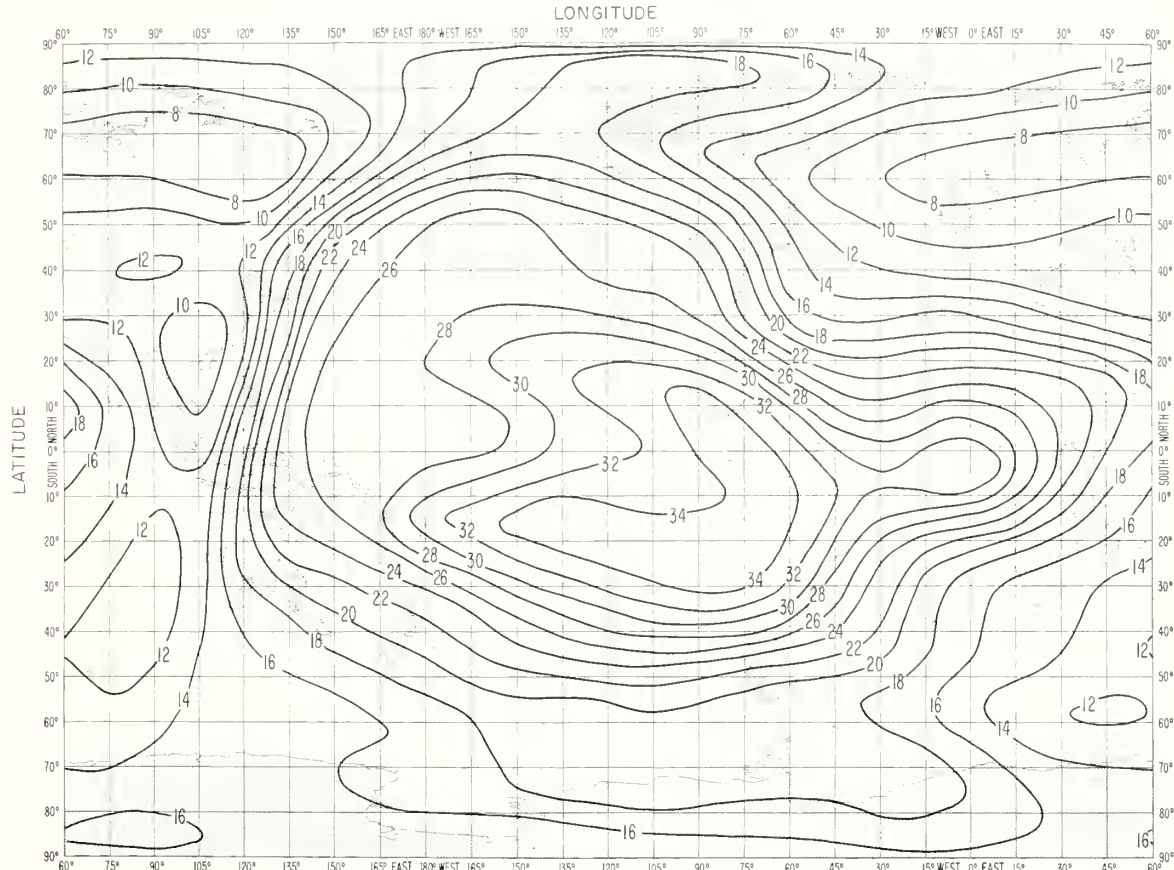


FIG I2B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

NORTH POLAR AREA
NOVEMBER 1963 UT = 00

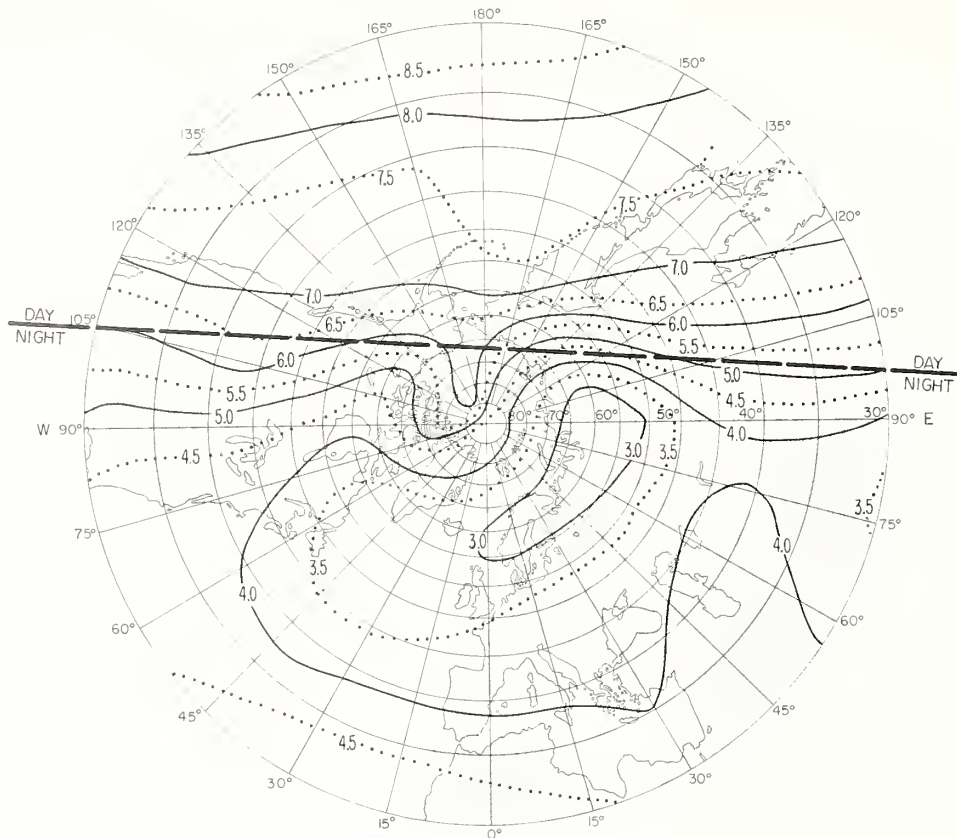


FIG. 13A. PREDICTED MEDIAN MUF(0)F2 (Mc/s)

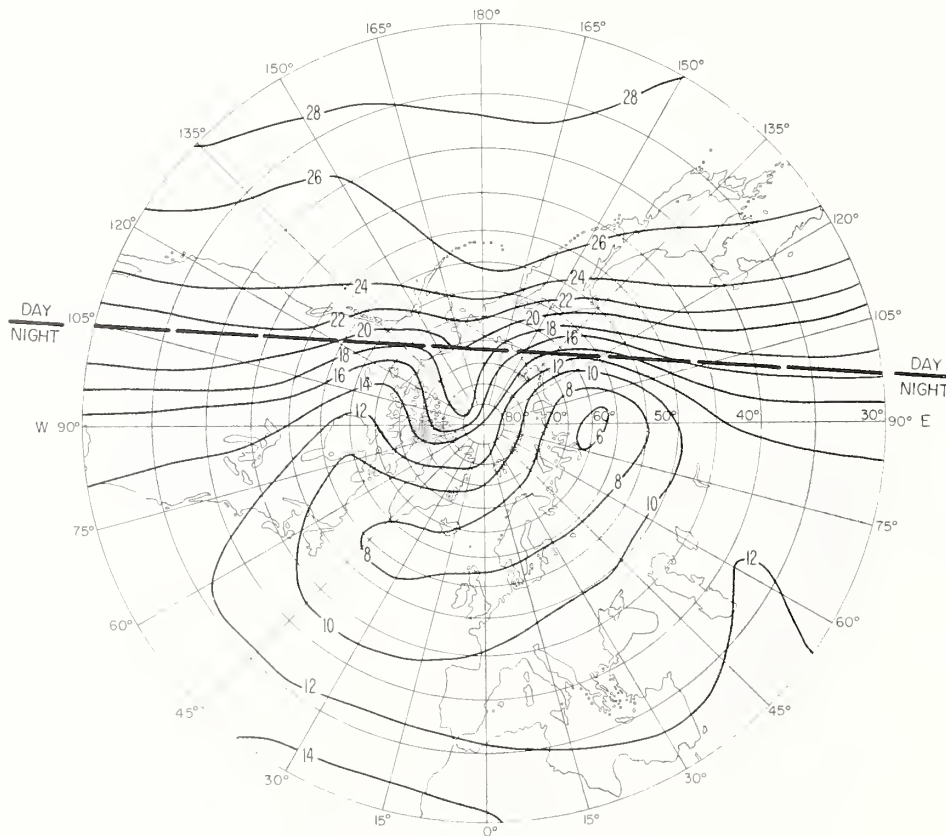


FIG. 13B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

SOUTH POLAR AREA
NOVEMBER 1963 UT = 00

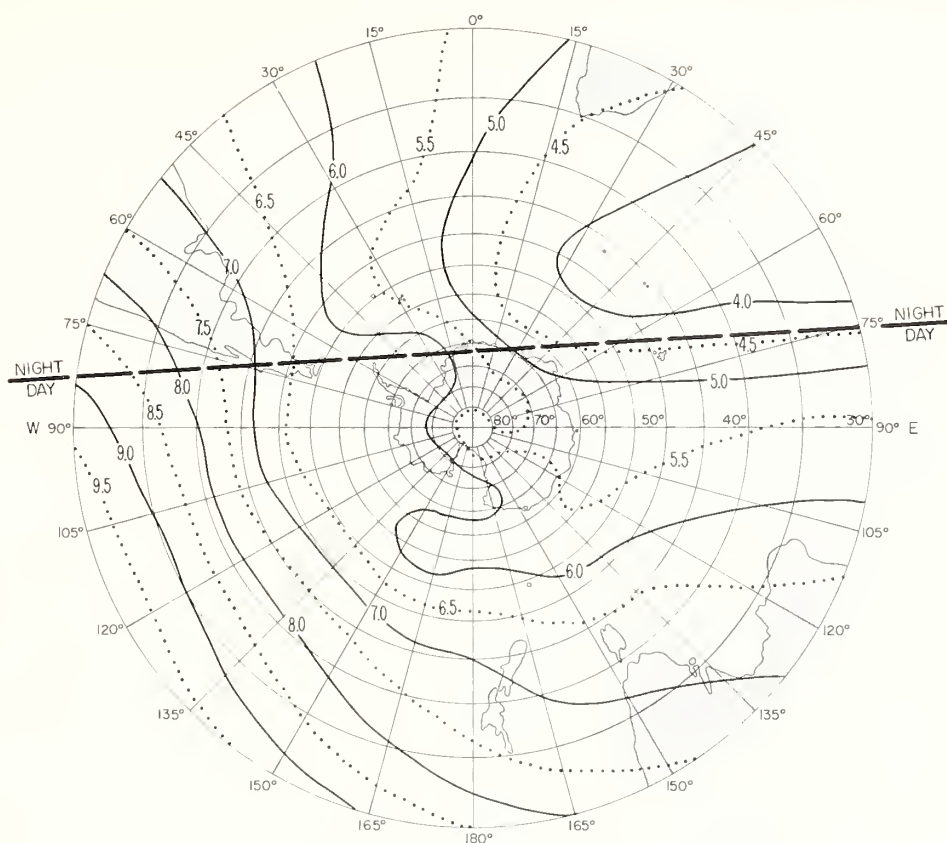


FIG. 14A. PREDICTED MEDIAN MUF(0)F2 (Mc/s)

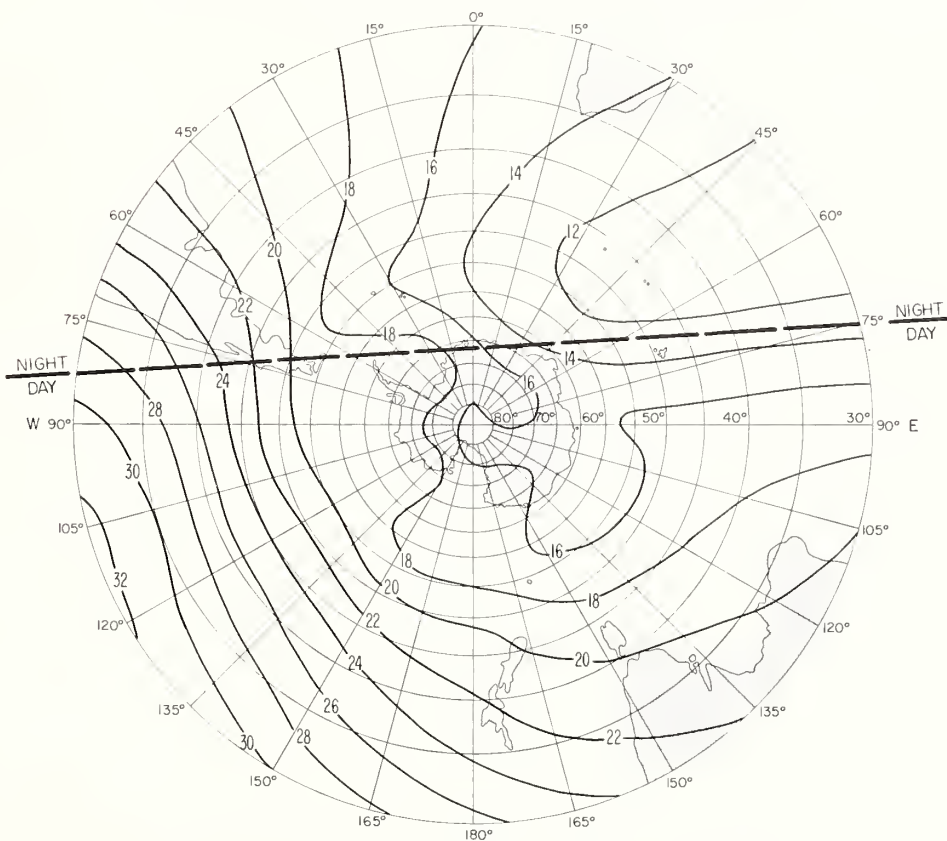


FIG. 14B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

NORTH POLAR AREA
NOVEMBER 1963 UT = 12

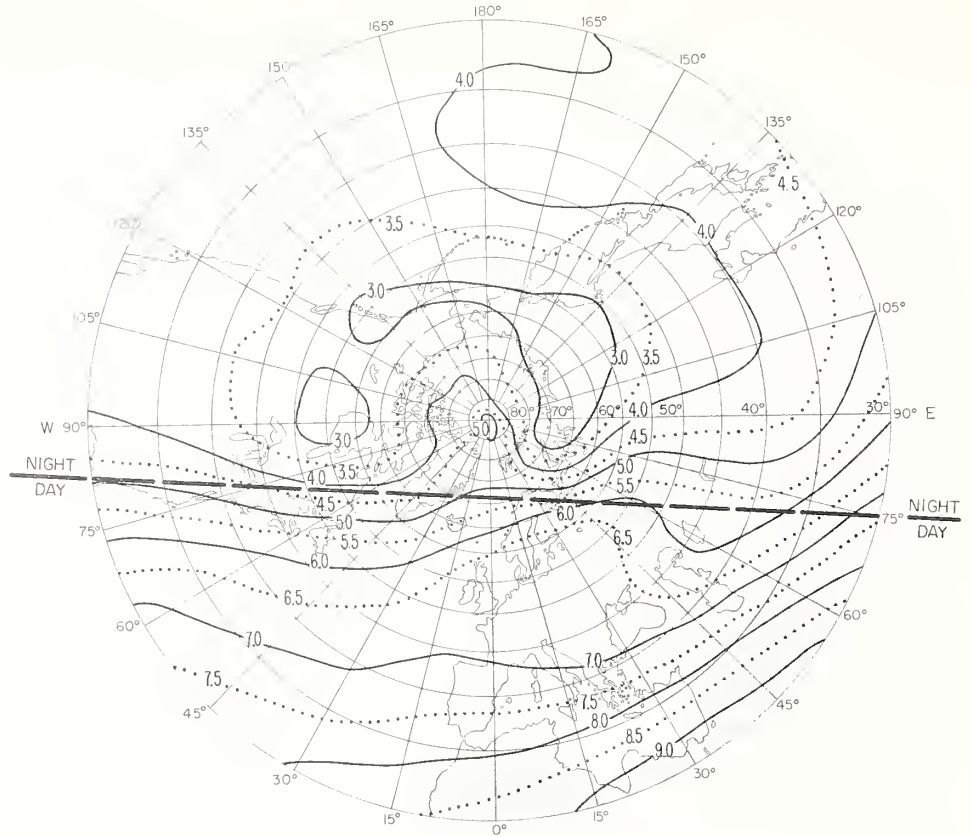


FIG. 15A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

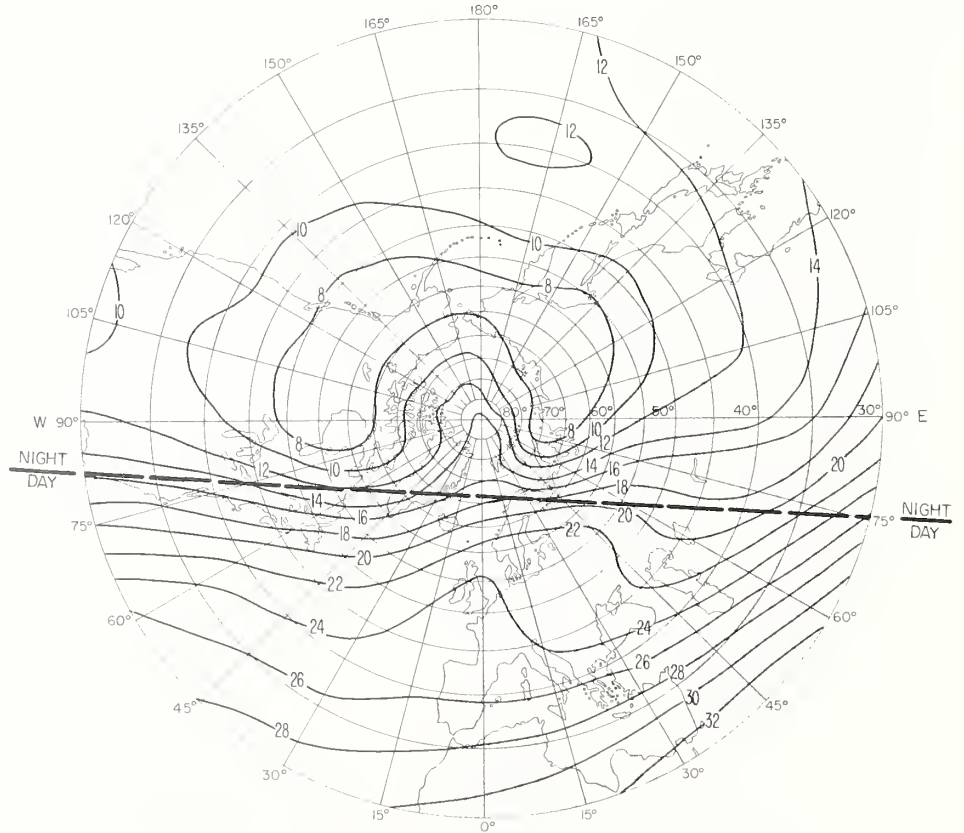


FIG. 15B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

SOUTH POLAR AREA
NOVEMBER 1963 UT = 12

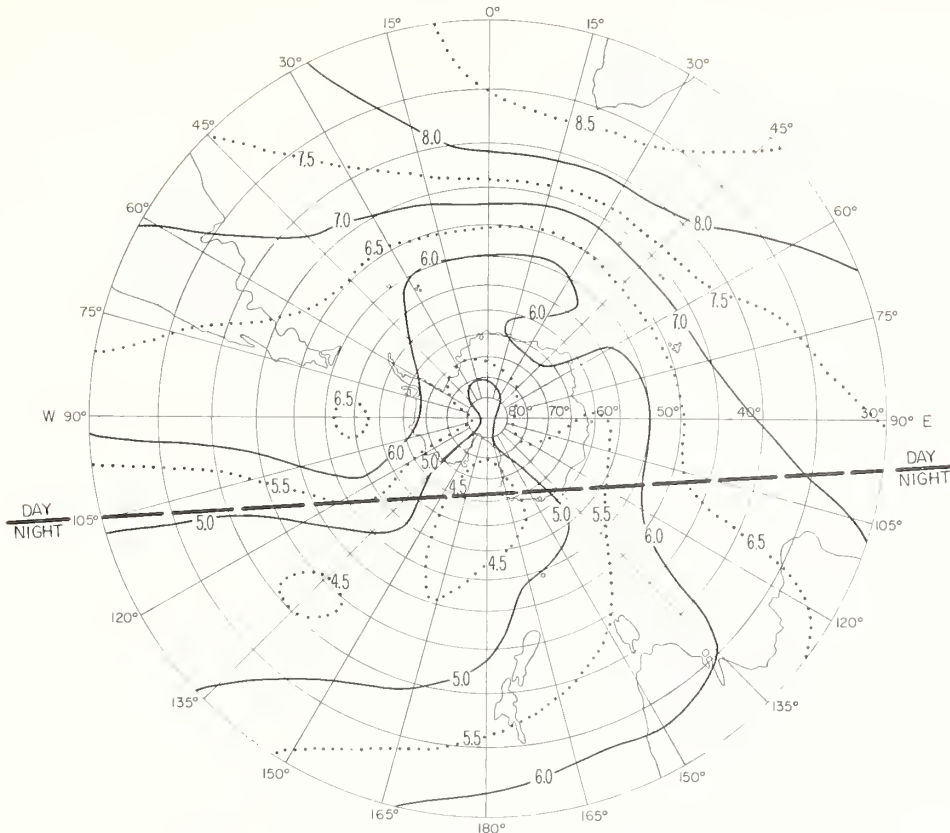


FIG. 16A. PREDICTED MEDIAN MUF(0)F2 (Mc/s)

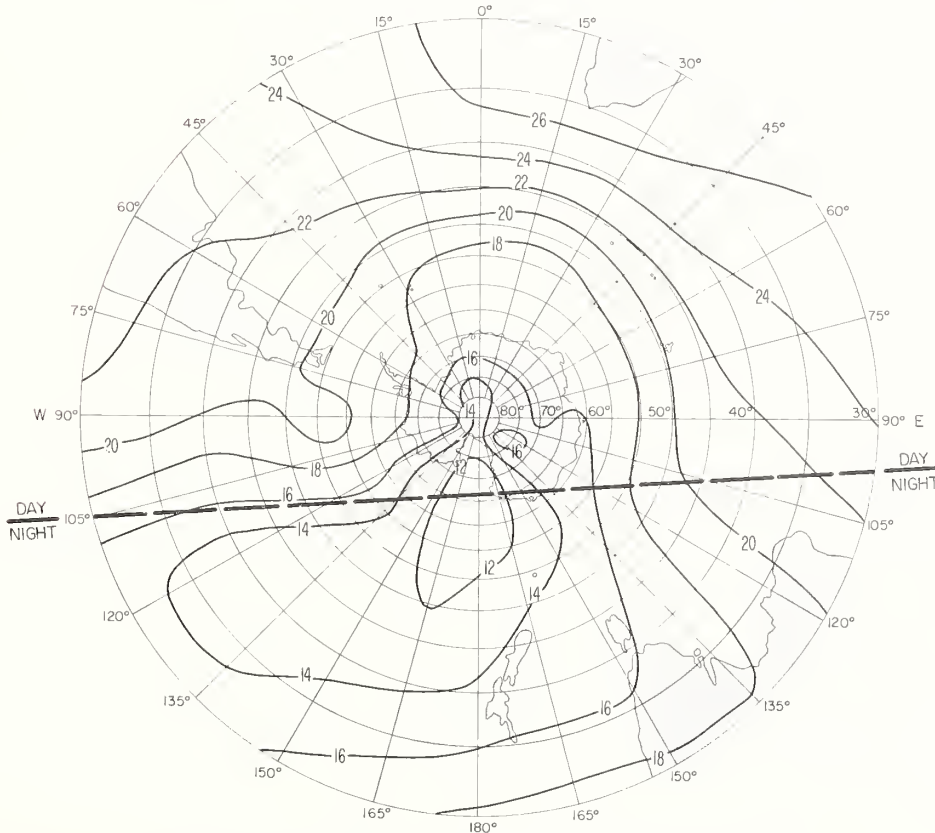


FIG. 16B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

HANDBOOK
for
CRPL IONOSPHERIC PREDICTIONS

Based on Numerical Methods of Mapping

NBS Handbook 90 — by S. M. Ostrow — 58 pages — December 1962 — \$0.40

All persons engaged in the solution of high frequency radio propagation problems will need this new *Handbook*, which replaces *Instructions for the Use of Basic Radio Propagation Predictions*, Circular 465 of the National Bureau of Standards.

Beginning with the January 1963 issue, the monthly radio propagation predictions from the Central Radio Propagation Laboratory of the National Bureau of Standards at Boulder, Colorado, will be entitled *CRPL Ionospheric Predictions*, instead of *Basic Radio Propagation Predictions (CRPL-D Series)*, as now called.

CRPL Ionospheric Predictions will fulfill the same functions as its predecessor. However, this new version will be prepared by numerical mapping methods, using an electronic computer. The predictions will be presented in two forms, giving the user the choice of either computer or graphical methods. Those using a computer will derive maximum benefits from the system. However, even when a computer cannot be used, the new prediction maps will provide more information than the earlier zone prediction charts, which were prepared by manual methods and designed primarily for graphical solution of high frequency propagation problems.

Thus the new *Handbook* is a necessity. All users of the *CRPL Ionospheric Predictions* should discard the now-obsolete *Instructions* and obtain a copy of the *Handbook*.

Use the order form below. Please order promptly so that you will have your *Handbook* by the time the January issue of *Predictions* arrives.

Superintendent of Documents
U.S. Government Printing Office
Washington 25, D.C.

Enclosed find \$_____ in check ☐ money order ☐ for which please send _____ copies of NBS Handbook 90, *Handbook for CRPL Ionospheric Predictions* to:

Name _____

Organization _____

Address _____

City _____ Zone _____ State (or Country) _____

(Please Note: Remittances from foreign countries should be by international money order or by draft on a U.S. bank.)

ERRATUM

Table 1 for May 1963 (IP # 2) through October 1963 (IP # 7) should be amended as follows:

The cutoff for the coefficients for the first order in longitude (II) should occur after $k=36$. The coefficients for the second order in longitude (III) should begin with $k=37$ and continue through $k=52$.

This error in Table 1 did not occur in the computations for the world-map contours. Figure 1 through 16, are correct as published.

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C., 20402

U.S. DEPARTMENT OF COMMERCE

Luther H. Hodges, *Secretary*

NATIONAL BUREAU OF STANDARDS

A. V. Astin, *Director*



THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colorado, is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title.

WASHINGTON, D. C.

Electricity. Resistance and Reactance. Electrochemistry. Electrical Instruments. Magnetic Measurements. Dielectrics. High Voltage. Absolute Electrical Measurements.

Metrology. Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Scale. Volumetry and Densimetry.

Heat. Temperature Physics. Heat Measurements. Cryogenic Physics. Equation of State. Statistical Physics. Radiation Physics. X-ray. Radioactivity. Radiation Theory. High Energy Radiation. Radiological Equipment. Nucleonic Instrumentation. Neutron Physics.

Analytical and Inorganic Chemistry. Pure Substances. Spectrochemistry. Solution Chemistry. Standard Reference Materials. Applied Analytical Research. Crystal Chemistry.

Mechanics. Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. Rheology. Combustion Controls.

Polymers. Macromolecules: Synthesis and Structure. Polymer Chemistry. Polymer Physics. Polymer Characterization. Polymer Evaluation and Testing. Applied Polymer Standards and Research. Dental Research. Metallurgy. Engineering Metallurgy. Microscopy and Diffraction. Metal Reactions. Metal Physics. Electrolysis and Metal Deposition.

Inorganic Solids. Engineering Ceramics. Glass. Solid State Chemistry. Crystal Growth. Physical Properties. Crystallography.

Building Research. Structural Engineering. Fire Research. Mechanical Systems. Organic Building Materials. Codes and Safety Standards. Heat Transfer. Inorganic Building Materials. Metallic Building Materials.

Applied Mathematics. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics. Operations Research.

Data Processing Systems. Components and Techniques. Computer Technology. Measurements Automation. Engineering Applications. Systems Analysis.

Atomic Physics. Spectroscopy. Infrared Spectroscopy. Far Ultraviolet Physics. Solid State Physics. Electron Physics. Atomic Physics. Plasma Spectroscopy.

Instrumentation. Engineering Electronics. Electron Devices. Electronic Instrumentation. Mechanical Instruments. Basic Instrumentation.

Physical Chemistry. Thermochemistry. Surface Chemistry. Organic Chemistry. Molecular Spectroscopy. Elementary Processes. Mass Spectrometry. Photochemistry and Radiation Chemistry.

Office of Weights and Measures.

BOULDER, COLO.

Cryogenic Engineering Laboratory. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Cryogenic Technical Services.

CENTRAL RADIO PROPAGATION LABORATORY

Ionosphere Research and Propagation. Low Frequency and Very Low Frequency Research. Ionosphere Research. Prediction Services. Sun-Earth Relationships. Field Engineering. Radio Warning Services. Vertical Soundings Research.

Radio Propagation Engineering. Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Propagation-Terrain Effects. Radio-Meteorology. Lower Atmosphere Physics.

Radio Systems. Applied Electromagnetic Theory. High Frequency and Very High Frequency Research. Frequency Utilization. Modulation Research. Antenna Research. Radiodetermination.

Upper Atmosphere and Space Physics. Upper Atmosphere and Plasma Physics. High Latitude Ionosphere Physics. Ionosphere and Exosphere Scatter. Airglow and Aurora. Ionospheric Radio Astronomy.

RADIO STANDARDS LABORATORY

Radio Physics. Radio Broadcast Service. Radio and Microwave Materials. Atomic Frequency and Time-Interval Standards. Radio Plasma. Millimeter-Wave Research.

Circuit Standards. High Frequency Electrical Standards. High Frequency Calibration Services. High Frequency Impedance Standards. Microwave Calibration Services. Microwave Circuit Standards. Low Frequency Calibration Services.

UNITED STATES
GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D. C., 20402

OFFICIAL BUSINESS

PENALTY FOR PRIVATE USE TO AVOID
PAYMENT OF POSTAGE. \$300
(GPO)

DEPARTMENTS OF THE ARMY
AND THE AIR FORCE
WASHINGTON, D. C., 20301, 1 August 1963

TB 11-499-8/TO 31-3-28, CRLP Ionospheric Predictions for November 1963, published for the use of all concerned.

BY ORDER OF THE SECRETARIES OF THE ARMY AND THE AIR FORCE:

EARLE G. WHEELER,
General, United States Army,
Chief of Staff.

OFFICIAL:

J. C. LAMBERT,
Major General, United States Army,
The Adjutant General.

CURTIS E. LEMAY,
Chief of Staff, United States Air Force.

OFFICIAL:

R. J. PUGH,
Colonel, United States Air Force,
Director of Administrative Services.

DISTRIBUTION:

Active Army:

USASA (4); USA Elet Comd (1); CSigO (1); USA MI Comd (1); USA Test & Eval Comd (1); USACD
Agcy (1); USA Msl Spt Comd (1); USCONARC (3); ARADCOM (2); OS Maj Comd (5); OS Base
Comd (2); Log Comd (2); MDW (1); Armies (5); Corps (2); Div (2); USA Elet RD Agcy (4); Svc
Colleges (4); Br Svc Sch (4) except USASCS (20); USAADCEN (2); ARADCOM Rgn (2); WSMR (2);
USA Elet RD Actv (4); JBUSMC (12); USA Corps (1); USA Mob Spt Cen (1); USAEPG (2);
Units org under fol TOE: 11-18 (1); 11-95 (1); 11-500 AC (1).

NG: None.

USAR: None.

For explanation of abbreviations used, see AR 320-50.